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SOME NOTES ON TROPICAL WATER SUPPLY AND STUDY OF FILTRATION AT PANAMA.*

BY HERMAN K. HIGGINS.

DISCUSSION.

[*January 24, 1912.*]

MR. E. W. CLARKE † (*by letter*). This paper is of special interest to the writer as he was resident engineer on the Colon Water Works during most of the time referred to by Mr. Higgins.

The first part of Mr. Higgins's paper is evidently intended to be more interesting from a humorous standpoint than from an engineering one, but I think, in justice to those connected with the work, the impression which might have been left in the mind of any one reading this paper that the development of the supply for Cristobal and Colon was a haphazard operation should be corrected.

Colon was built by and because of the Panama Railroad, and while the writer has no personal knowledge of the early water supply at this city, as soon as the railroad shops were established, a supply was furnished to them from a small reservoir at Mt. Hope, and incidentally the inhabitants, who were mostly railroad people, were supplied with water during the dry season. During the balance of the year, — that is, from the middle of April to the end of December, — no artificial supply was necessary for drinking purposes, and such things as closets or baths did not exist outside of the houses of a very few of the higher officials. As Mr. Higgins states, water was at times brought from the Frijoles River for

* JOURNAL N. E. W. W. A., Vol. 25, p. 454.

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drinking purposes only, and supplied to the people at the water stations, one of which is shown on Plate III of Mr. Higgins's paper.

The Panama Railroad Company had at least two sources of supply during the years previous to 1900, both of which were extremely small, but were sufficient to serve their purposes, and they never pretended to supply the city of Colon with water. The water stations were maintained for the use of their own employees during the dry season, who received water free, and for non-employees on the payment of a nominal fee.

After Cristobal was built, a water supply was obtained for a time from the west side of Limon Bay, as described by Mr. Higgins, from a stream draining a very small catchment area on the east side of the hills east of the Chagres River. Later, an infiltration well was sunk near Mt. Hope Station, — or Monkey Hill, as it was then called, — three standpipes holding about 30 000 gal. erected on a nearby hill, and a 4-in. main laid to Cristobal with a small distribution system in the town. No connections were made to the houses with the exception of two buildings locally known as "De Lesseps palaces," while the general inhabitants were served with one hydrant in each street. In the De Lesseps palaces, a limited number of faucets were placed, and two shower-baths. This system was not in operation when the United States took possession of the canal in May, 1904, but the resident engineer on the canal work at Cristobal repaired the pump at the well, and got the system into partial running order sometime in June of that year.

The writer arrived on the Isthmus in the latter part of July, and reconnoissances and surveys were begun for the location of an adequate supply of water for both Colon and Cristobal. The possible sources were four in number, and three were quickly eliminated for economic reasons. The fourth was on Brazos Brook about two miles east of Mt. Hope Station, and it was largely a matter of Hobson's choice that this brook was selected as a source of supply, as it was recognized from the beginning that the reservoir would be a shallow one, and that conditions would be ideal for the growth of algæ. A report on the subject with plans and recommendations as to details of work was made to my superior

in December, 1904, and authorization to begin construction was received in March, 1905.

In December, 1904, I was instructed to take charge of the maintenance of the water supply for Cristobal, and as the infiltration well mentioned gave evidence that it would be unable to supply the demand, it was imperative that some quickly available substitute be found. About three quarters of a mile east of the railroad at Mt. Hope was the unfinished east diversion channel for the Chagres River, connecting at Mindi with the Mindi River, which in turn flowed into Limon Bay. The water in the channel during the wet season was fresh, and it was hoped that the volume was great enough so that it would remain at least suitable for boiler use during the dry season.

Two old French pumps were set up at the end of this channel, and a pipe line laid to connect with the standpipes mentioned as being part of the old French system. At this time, no cast-iron pipe had been delivered on the Isthmus, and this line was made up of old French pipe, both cast- and wrought-iron, from $2\frac{1}{2}$ in. to 4 in. in diameter. As very few specials were to be found in the storehouse, changes from one size to another were made by pushing the smaller pipe into the larger, leading up the joint as well as possible, and placing concrete around it. The result of such construction was, of course, enormous friction. The static head was about 35 lb., but the pumps habitually ran under pressure of 65 to 70 lb., and as they were not designed to work under such pressures, the leather valves were continually giving out.

In spite of this, we managed to pump about 30 000 gal. per day into the standpipes. This was largely due to the patience and efficiency of the white machinist in charge of the pumps, who lived in a shack within a stone's throw of the station, and was up at all hours of the day and night endeavoring to make up for the inefficiency of the plant with which he was working. His assistants were Jamaica negroes, who were usually extremely ignorant and careless, and twice, during the operation of these pumps, crown sheets were burned out, necessitating the replacement of the boiler.

The pumps were not the only source of trouble in operating the system. Leaks were of weekly occurrence in the pipe line, and

one valve had an annoying habit of closing from its own weight on account of the thread being stripped from the stem. The "very short, very fat, very profane" man, spoken of by Mr. Higgins, spent most of his waking time keeping this line in service.

As Mr. Higgins states, a distribution system was laid through Cristobal, and early in 1905 practically all the houses were provided with showers and water-closets, which was a decided improvement over the condition six months previous, when there were two shower-baths in town and water-closets were unknown.

By the 1st of April, the water in the diversion canal became brackish and finally practically salt water, so it was used only for flushing purposes. For drinking purposes during the early part of the dry season, dependence was placed on the rain-water barrels, which had been screened by the sanitary division, and as these barrels were generally in places easily accessible to any one, the consequence was that the negroes took water from any tank they saw fit, and by the 1st of February the supply was practically exhausted. Recourse was had to six reserved rain-water tanks having a combined capacity of 65 000 gal., and while an effort was made to restrict the use of this water to drinking exclusively, and daily permits were issued for this purpose, doubtless a considerable portion was used for washing. This tank supply finally failed, and water was then hauled from Frijoles by the railroad for a period of two or three weeks, and pumped into tanks, as shown by Plate I of Mr. Higgins's paper, which is a view probably taken in April, 1906, in the easterly part of Cristobal.

In May or June, pipe began to arrive from the United States for use in the Panama system, and sufficient 6-in. pipe was diverted to relay the line from the diversion canal to the tanks, and also to repair the 4-in. line. The pressure on the pumps promptly dropped to about 40 lb., and our pump troubles were over. Previous to this, a small dam had been built near the pumps, which collected water from a small drainage area, and the heavy rains of the latter part of May filled the pond, and gave fresh water for use at Cristobal.

It was realized that it would be impossible to construct the main dam, outlined in the report on the Colon Water Works, in time for use during the dry season of 1905–6, and, therefore, the temporary

dam at the upper end of the watershed was constructed during the summer of 1905. Here again, we were working under most adverse circumstances, due principally to lack of material. For instance, in order to control the water during the placement of the embankment, a 4-ft. flume was designed to pass through the dam, and as it was impossible to get any dimension lumber on the Isthmus at that time, it was built up of four layers of 1-in. tongued and grooved California redwood, nailed together on forms, giving practically a circular section, and reinforced with telegraph wire, clinched up by means of home-made contrivances around the outside. This makeshift naturally enough gave trouble, and before the dam was entirely finished, we were forced to place posts nearly its entire length to prevent its crushing.

The site of the temporary dam was nearly a mile from the end of the narrow gage railroad to the main dam, and neither time nor number of men permitted the construction of a roadbed capable of supporting even our three-ton locomotives, so a line on which cars were pushed by hand was laid, and over this was hauled such material as we were absolutely forced to import for the construction of the dam. The cost of transporting coal prevented the use of steam for pumping, and an old hand fire engine, which we found at Cristobal, was put into service at the dam, and pumped water to puddle the bank. This dam was finished in time to collect the rainfall during October and November, 1905, but the abutting hills and the foundations proved so very pervious that a very considerable leakage occurred, and a secondary dam was built a few hundred feet down stream. The 8-in. spiral riveted pipe line passed through this latter dam, and towards the end of the 1905–6 dry season, the leakage from the upper dam was admitted into the pipe at this point, so that while, as Mr. Higgins states, the water in the upper reservoir was below the outlet of the pipe, a large proportion of it was eventually caught and used at the lower dam. In the meantime, the 20-in. pipe line from the main reservoir for Colon had been laid as far as the diversion channel, a connection made with the pump at this point, and Cristobal was supplied from Brazos Brook-shed during January and February, 1906. When this supply finally gave out, recourse was had to the diversion canal, salt water was again pumped into the

mains, and tank cars brought fresh water down from Frijoles. The writer left the Isthmus in May of 1906, and has no personal knowledge of later conditions.

The only claim which the work done by the Municipal Division on the Isthmus during 1904–6 has for recognition by the profession is in the difficulties under which it was accomplished.

Fortunately, the *morale* of the engineering force was most excellent, and every one of the men did the best he could to make the work a success, and it was owing to this attitude on the part of the members of the force that in spite of difficulties due to lack of material and of labor that the first two years of the American occupation of the Isthmus saw the completion of the design and construction of water works and sewer systems for practically every town on the Isthmus and also for the cities of Colon and Panama. The men put up with discomforts and inconveniences of which later arrivals on the Isthmus had very little idea, and while the experience can be laughed at as we look back upon it, it was anything but laughable at the time; and the work done, while doubtless having many defects, was the result of a great deal of hard work and ingenuity on the part of every member of the Municipal Division. What has been said of the work at Colon and Cristobal applies with equal force to the work done at all the towns across the Isthmus.

THE RELATIVE CORROSION OF IRON AND STEEL PIPE AS FOUND IN SERVICE. [ABSTRACT.]

BY WILLIAM H. WALKER, PH.D., PROFESSOR OF INDUSTRIAL CHEMISTRY AND DIRECTOR OF THE RESEARCH LABORATORY OF APPLIED CHEMISTRY, MASS. INSTITUTE OF TECHNOLOGY.

[*Read December 13, 1911.*]

There are few subjects relating to the corrosion of metals which have received so much attention, or around which there has centered so spirited a discussion, as the relative merits of iron (meaning thereby wrought iron) and steel. The fact that this matter is one still receiving attention, notwithstanding the great volume of accumulated and available literature, is due to a number of causes, among which may be mentioned; — first, that although the words "iron" and "steel" carry with them a definite idea as to general methods of manufacture and some of the more easily discernible properties, they convey no idea as to standards of value. It is possible to make very poor iron and very good steel, and it is just as possible to make the reverse. Hence, when an investigator compared the corrosion of a poor iron with a good steel, he obtained results which favored steel; when the material under study was the reverse, iron was shown to be the more resistant metal. Second, there is a woeful lack of uniformity of conditions obtaining in many if not most of the experiments which have been carried on for the purpose of comparing resistance to corrosion. Some specimens were large, some small; some cleaned of scale, others not; some immersed in deep water, others in shallow water, etc. The corrosion of iron is so sensitive to changing conditions of surface, oxygen concentration, salts in solution, and the like, that only when the most careful preparation is made to maintain all conditions constant, is a comparative test of value. We will not discuss these conditions here, but take pleasure in referring the reader to that most excellent book, "The Corrosion of Iron and Steel," by Dr. J. Newton Friend, where a complete treatment of the general subject will be found. Third, many times opinions are formed and

expressed by the casual observer which fail to take into consideration not only the fundamental conditions necessary to accurate comparative work, but also less obvious conditions which make a comparison unreliable. For example, a person may notice the rapid rusting of a cheap grade of steel wire fencing which had originally but a wash of zinc as a substitute for galvanizing, and thus become suspicious of the durability of all steel. Or he may notice holes in a metal roof put up in place of a material known to have lasted a much longer time than the new roof. He concludes that the later is of less value without having any knowledge of the change of conditions in the locality, class of metal, and the thickness of the new roof, nature and thickness of the galvanizing or other protective coating, and so forth.

Owing to the proverbial conservatism of New England, the introduction of steel pipe has been slower in this territory than in other parts of the country. There is a tendency to pronounce any pipe which withstands corrosion as being wrought iron, while the fact that a pipe corrodes easily is considered by many proof in itself that it is steel.

To determine what the facts actually are in regard to the relative life of service pipes which have been in constant use for a considerable number of years throughout New England, an investigation was undertaken in which it was proposed to seek out instances where steel and iron pipe had been used together in the same system; and further, where the two kinds of metal were separated in this system only by a coupling. Any influence which the coupling might have would be present equally with the iron and with the steel, while conditions of oxygen concentration, temperature, pressure, flow of water or steam, etc., would be as nearly identical for the two kinds of metal as it is possible to obtain. It was intended also to collect in this way material of known resistance or tendency to corrosion, in order to further test the applicability or truthfulness of the so-called "acid corrosion test." While the majority of the pipe so obtained was from hot and cold water feed systems, enough were selected from live and exhaust steam lines, hot-water and steam-heating systems, etc., to make the conclusions drawn of general application. The investigation was necessarily tedious in that each pipe had to be examined to determine whether

it was of iron or steel, and many instances were found that would have served our purpose well, but where it was impossible to remove the pipes from the system. The pipes were sent to the laboratory where they were each split lengthwise into halves, and carefully cleaned from scale and rust by soaking in an ammonium citrate solution, with an occasional brushing. In this way the scale and rust were removed without dissolving any of the iron. An estimation of the extent of corrosion was made by measuring with a micrometer gage the ten deepest pits per unit distance of length.

The results are a splendid vindication of the principle that if oxygen be excluded or taken from water, no corrosion will take place. When the water in the lines examined was stagnant, as in fire-sprinkler systems for buildings, or in lines where the water was circulated over and over again without exposure to the air, as in some hot-water heating systems, no corrosion was to be observed. On the other hand, where fresh water was constantly added to the system, and heated within the system, corrosion was very rapid and in some cases excessive.

We were able to get sixty-four comparisons of iron and steel where the history of the installation was known. The results are as follows:

Comparisons where iron was found more corroded than steel,	20
Comparisons where steel was found more corroded than iron,	18
Comparisons where steel and iron were equally corroded,	9
Comparisons where corrosion was negligible,	17

These results again demonstrate that taken *on the average* there is no difference in the corrosion of iron and steel pipe. Conversations held with the engineers in charge of plants during this investigation confirm the statement already made that a pipe is frequently called steel when corrosion is found to be excessive, while it is set down as iron if it rusts but little.

In order to get some measurement of the influence of oxygen in the water of the modern hot-water supply system, a relatively large scale experiment was carried on at the plant of the Walworth Manufacturing Company in South Boston. Two coils made up from pieces taken from the same length of pipe were each fed with

water from the same source at the same temperature. In one case the water was heated to 85 degrees cent. in an *open tank*, while in the other the water was heated to the same temperature in a *closed* tank. The feed water contained on the average 5.85 cc. of oxygen per liter, and passed through each coil at the rate of one-half gallon per minute. After running 1 750 hours the coil fed with water heated in an open tank had lost 22 gm., while the coil fed with water heated in a closed tank had lost 155 gm. In neither case was the oxygen completely removed; if the water in the open tank had been gently *boiled*, corrosion in the coil fed with this water would have been entirely prevented.

In order to show what relation may exist between the so-called acid corrosion test and the real corrosion as found in service, eleven pairs of iron and steel were selected and subjected to 20 per cent. sulphuric acid for four hours at room temperature. Four pairs were selected in which the steel was decidedly better than the iron in service, four in which the iron had shown decidedly better than the steel, and three in which there was no difference between the two metals.

In six instances the relative corrosion as shown by the sulphuric-acid test corresponded with the corrosion as found in service. In five instances corrosion as shown by the acid test was exactly contrary to that found in service. Although the greatest care was taken to have the specimens of the same size, cleaned in the same way, and in the same physical condition, the results show that no reliance can be placed in this accelerated acid test, but that it may be entirely erroneous and very misleading. Not only did the acid test not agree with the service test when steel was compared with iron, but the steels failed to agree among themselves, and the irons showed no agreement when considered by themselves.

DISCUSSION.

THE PRESIDENT. It was known long ago that pipes rusted, corroded, and in time had to be replaced. But when pipes are corroded there is action and reaction; the pipe is destroyed and the water also is affected. Some of the iron goes into solution in the water, and afterward, when the water is drawn, the iron

separates and makes the red-water trouble we have heard so much about.

Now, my friends the pipe men tell me that if we will only give them a decent water to put through the pipes, the pipes will be all right, and some of the superintendents say that, if we only had decent pipes to send the water through, the water would be all right. There is probably some truth on both sides, and we want to find out to-day as much about it as we can, and see what kind of treatment will clean up this red-water trouble. We have heard from Professor Walker of the Institute of Technology, who has been studying this subject most carefully for several years, and have discovered a new point of view as to the quality of water. We are to consider it from the standpoint of the pipe. We have learned that a good water, from the standpoint of the pipe, is one that does not carry oxygen, that does carry plenty of organic matter, and that is also hard.

Now, gentlemen, that is not the standard we have been working for from the standpoint of the consumer. Perhaps we have been looking at it from a wrong point of view. We have been trying to give the people water which was good for them, but perhaps we shall have to turn about and give the pipe water that is good for the pipe.

Mr. Speller represents a company which, a few years ago, was a very large, perhaps the largest, manufacturer of wrought-iron pipe in the country, and his company has now given up making wrought-iron pipe and is making only steel pipe. I am going to call upon him to say what he can for himself, and justify his course if he can. And in doing this, I want him to bear in mind that this is not altogether a question between steel pipe and wrought-iron pipe; it is not a question whether he can get the wrought-iron business for the steel pipe, but it is a question whether either steel pipe or wrought-iron pipe is going to answer the requirements of the members of this Association for the water which they supply to their consumers.

MR. F. N. SPELLER.* *Mr. President and Gentlemen,* — From what has just been said I judge you are aware that we have followed this question as between wrought iron and steel pretty

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closely, and that we have been particularly interested, especially during the past six or eight years, in the matter of durability. Naturally so, because most of our product cannot usually be protected by coatings, and therefore it becomes very important to make it as durable as possible in the natural state. Our work has been very largely furthered by the researches of such scientific investigators as Professor Walker. They have laid the foundation on which we, who have less time to go deep into fundamental principles, have worked.

Dr. Walker's work has been so extensive in New England as to be practically conclusive as regards pipe in that district; but it may be just as well to give the results of similar investigations in other localities which Dr. Walker's researches closely corroborate in order to broaden out the scope of our conclusions.

We have records of four similar investigations (Table 1, page 17) made on pipe in water lines where wrought iron and steel were used together; I do not know why they were put in together, but there they were so found. More than likely it was simply accidental.

In the first place, you will find in the *Engineering News* of December, 1910, a report on the condition of the hot-water lines in the New York City bath houses, made by Prof. Ira Woolson for the city of New York. Eighty-nine samples were secured, seventeen of which were wrought iron. The corrosion was reported as practically equal.

The next one we come to is an investigation made in the boiler feed-water lines of the Frick Coke Company, at Scotdale, Pa. Here we have an entirely different class of water in a different locality. The relative corrosion there was found to be 100 in the case of wrought iron as against 99 in the case of steel. The average depth of the pitting in 21 lots, including the wrought iron and steel samples, was .112 of an inch in the wrought iron and .108 in the steel. In all these investigations there was found for the same length of exposure a very considerable difference between one sample and another, as much as 25 per cent. one way or the other, but on averaging up a sufficient number of samples in the same system, or in different systems, and making comparison, the results come out almost exactly the same, as Dr. Walker has found in New England.

Another investigation was made in the Cresson coal fields, with water of various characters, and leads to the same conclusion, viz., — 100 for the wrought iron as against 99 for the steel.

Later still, in the past summer, it happened that the hot-water supply lines gave out in the Allegheny General Hospital. This pipe was put in seven or eight years ago and it was decided to remove the entire system. This offered a splendid opportunity, and by arrangement with the architects we put one of our research men on the plant with instructions to take a sample from each length of pipe as it was taken out, leaving a portion of each length with the architects for independent examination. Out of 69 samples taken from the hot-water system, 42 were wrought iron and 27 turned out to be steel. The average depth of pitting in the wrought iron was .092 of an inch and in the steel .094, — practically the same again.

So we have, including Dr. Walker's research, over 150 cases where a true comparison between iron and steel pipe is possible.

So many factors are introduced in corrosion where the metals are exposed to the atmosphere or underground that it becomes very difficult to make a comparison, and no comparison can be safely made unless both materials are put into service at the same time and in such a way as to leave no doubt as to the environment being practically the same. The conditions which obtain inside a water line as in the cases cited we can agree, I think, meet the requirements of a perfect comparison as near as can be, for here we have the two materials coupled together and carrying the same water both as to quality, quantity, and temperature.

We have made galvanic tests of wrought iron and steel to learn if there was any difference of potential and find a slight difference, but not always in the same direction, for sometimes the wrought iron and at other times the steel will be the anode. Moreover, the current tends to reverse itself as corrosion proceeds, the anode because of the hydrated oxide which collects on its surface becoming the cathode. In any case the current caused by contact is so exceedingly weak as not to influence the corrosion of the metal more than a small fraction of an inch away from the contact, and

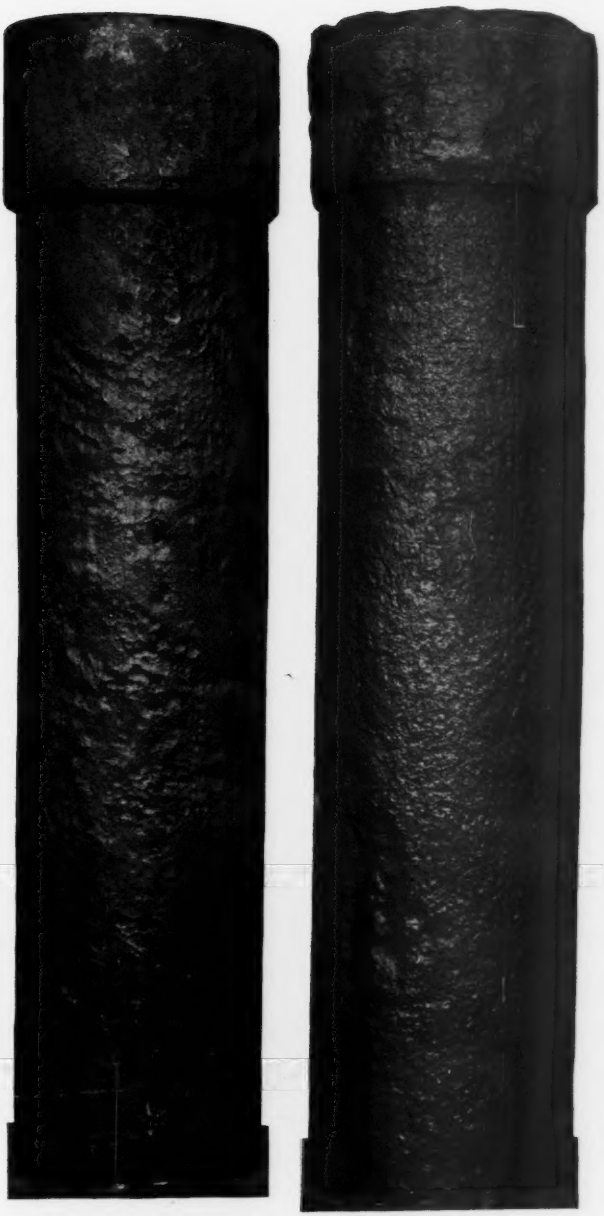
all comparisons as to pitting in the tests referred to were taken at a safe distance from the joint.

The results of these experiments also indicate the error of the claim that absence of manganese * and the presence of considerable cinder † are controlling factors in lessening corrosion. Mill scale which forms on the surface of iron and steel on cooling in the air has the strongest potential difference of all the materials which are likely to be found in or in contact with iron and is the most frequent cause of pitting. Mill cinder which is formed in irregular patches and strings in puddled iron has about the same difference of potential, and, being decidedly electro-negative to iron, greatly accelerates the solution of the metal. There may be something in the claim of the mechanical protection from cinder, for it is a good protector when the entire surface of the metal is covered, but this protection becomes worse than useless when the cinder is in exposed contact with the iron, as it then causes corrosion to proceed at irregular and greatly accelerated rates on the exposed surface, which results in the familiar phenomena known as pitting.

Another instance where a true comparison may be drawn might be here referred to (and many more could be added), since it indicates that the general conclusion we are forced to regarding pipe materials is not restricted to water lines. About thirteen years ago in the Ohio and Indiana oil field some operators started to use steel casing for the wells and it later came to be used exclusively by these companies, but for a few years wrought iron and steel were kept in stock and put in together, as it frequently happened, in the same well. By examining a number of strings of casing recently pulled which date back to this period, cases were found where the iron and steel were screwed together, and invariably where one is affected the other is damaged to practically the same degree. The same may be said of the couplings which have always been made of iron, an example of which is shown in Plate I. So far, then, as the steel pipe made during the past twelve years or so is concerned, there appears to be little to choose between it and the wrought iron of the same period. It might be inferred from

* An investigation described in *Journal of Iron and Steel Institute*, Vol. LXXXIII, p. 189, 1911, indicates that manganese compounds tend to protect iron from corrosion.

† See p. 172 (*Ibid.*) as to the influence of cinder and mill scale.



COMPARISON OF STEEL PIPE AND IRON COUPLINGS FROM INDIANA OIL FIELDS, AFTER 15 YEARS' SERVICE.

this experience that since some of the factors controlling corrosion have been better understood and steel has been made with due regard to its durability in the light of the late scientific study of corrosion, that modern steel so made is superior to wrought iron, and tests under way indicate this to be the case, although non-corrodible iron has yet to be discovered.

How, then, some of you will ask, can we explain certain experiences which have been cherished almost as trade marks by some of our friends who still claim to be manufacturing wrought-iron pipe? It has been found in a few isolated cases that wrought-iron pipe made before steel pipe was thought of has outlasted steel put to the same use many years after. It is hardly likely that the wrought iron made in the early days of pipe manufacture was so much better or the steel so much worse than nowadays, although this may in some measure account for such cases. It seems more probable that the early history of the treatment of the surface of these old pipe in or after manufacture, whereby it acquired some effective protection, will account for such cases of extraordinary resistance to corrosion. The strong resisting qualities of a silicious iron scale formed in manufacture or the natural scale formed and dried on the surface by years of exposure under mild conditions of intermittent corrosion may afford the necessary permanent protection, if indeed it was not after all due to a forgotten coat of good paint, for the early history of these isolated cases cannot be said to be known with any degree of certainty. In a study of the corrosion of metal on the Panama Canal two years ago, we found several cases of this kind in looking over some old French junk — of course, as in other instances, these pieces of apparently unprotected pipe were conspicuous by their rarity, most of this material not so fortunate having dissolved and disappeared. Some of these pipes which showed no evidence of paint, but which had a thin, hard, badly weathered scale, were threaded for a foot or two and hung up to the moist breeze on the Pacific coast with some pieces of new steel pipe of about the same thickness, which, of course, were similarly treated. In six months they were both badly and equally corroded and the old iron was found to have lost more in this time than in the previous twenty-five years.

The apparent inconsistency between the facts as found in these

investigations and the opinions quite generally held as to the superiority of wrought iron is not difficult to understand when we consider —

1. How few who hold to this opinion base it on anything more than what they have heard others talk of, whose experience frequently amounts to nothing but general observation or inference from results of what they have seen with iron or steel products other than pipe, from which it is unfair and misleading to draw comparison.

Confusion of opinion has resulted from treating the question of corrosion too generally. We cannot compare all kinds of steel as a class with all sorts of wrought iron. We are just beginning to learn that well-made sound steel is not only as durable as the best wrought iron on record, but for special conditions, for example, where acid conditions prevail, steel may be made so as to be many times more resistant than iron.

2. From the demonstrated fact that the majority of those handling pipe day by day are half the time unable to tell wrought iron from steel.

3. That corrosion conditions are generally much more severe nowadays and have become more so, much in the same ratio as the relative proportion of steel pipe has increased, so that it would only be natural to connect the more general use of steel with the observed decrease in useful service of pipe in certain localities.

4. The important influence of the man who handles the pipe, who not infrequently prefers wrought iron as being somewhat easier to thread with the average die and because it is a union-made product as against steel made in non-union mills.

All these and other influences which have been used to fan and keep alive a prejudice, steel pipe has had to contend with and live down.

THE PRESIDENT. Gentlemen, there seems to be no doubt but what many samples of wrought-iron pipe in the old days lasted much better than the pipe which has been put in recently, and Mr. Speller, I see, goes back to the idea that perhaps the water that they had in the old days was better for the pipe than the water that we have now. I expect that was often the case, because it seems to be generally true that the cleaner the water, the harder

TABLE 1.

CASES OF COMPARISON OF WROUGHT IRON AND STEEL UNDER INTERNAL CORROSION IN WARM WATER SUPPLY LINES.

Summary of Results of Investigations on Record during the Past Two Years.

Locality.	Number of Cases on Record.	Average of Deepest Pits. W. I.	Average of Deepest Pits. Steel.	Reference for Details. Remarks.
New York City Bathhouses.	89 samples secured, of which 17 were wrought iron.	Equal 100	100%	*Engineering News*, Dec. 3, 1910, p. 630; or N.T.C. Bulletin No.2. Conditions were those of actual service and pipe was tested to destruction.
Frick Coke Co. Power Plants	21 lots, comprising 52 samples, of which 26 were wrought iron and 26 steel.	.112 in. 100%	.108 in. * 96%	*Engineering Review*, April, 1911; or N.T.C. Bulletin No. 3; or Amer. Soc. Heating & Ventilating Engrs., 1911. Conditions were those of actual service, varying from 6 months to 7½–8 years.
		100%	99% †	
Cresson Coal Fields	20 samples, of which 10 were iron and 10 wrought steel.	.094 in. 100%	.093 in. ‡ 99%	Preliminary report of J. J. Wilson, Aug. 29, 1911. Conditions those of actual service, varying from 6 months to 10 years.
Allegheny General Hospital	81 samples, of which 69 are from the hot-water lines, 42 wrought iron and 27 steel.	.105 in. 100%	.105 in. * 100%	Preliminary report of D. R. Mason, Dec. 8, 1911. Conditions those of actual service; pipe was tested to destruction.
		.092 in.	.094 in.†	

* Depth of deepest pit in wrought-iron samples taken as 100 per cent.

† Average depth of five deepest pits in wrought-iron samples taken as 100 per cent.

‡ Average depth of four deepest pits in wrought-iron samples taken as 100 per cent.

it is for the pipe. That is a feature of the situation which must be taken into account. At the same time we find that in many important enterprises, where people are studying the conditions very carefully, they think they had rather have wrought-iron pipe, and they are willing to pay a substantial increase in price in order to get it. We want to know whether this is prejudice or whether there is some foundation for the preference. We are fortunate in having with us to-day Mr. George Schuhmann, the vice-president and general manager of the Reading Iron Company, one of the largest, perhaps the largest, manufacturers of wrought-iron pipe in the United States. I have great pleasure in introducing Mr. Schuhmann.

GEORGE SCHUHMANN, ESQ. *Mr. President and Gentlemen,* — In order to make my arguments clear to you, I may have to bore you a little at first with a description of the manufacture of wrought iron.

Mr. Speller mentioned that iron made many years ago was probably made better than iron is made nowadays. In reply to this I wish to state that we make our wrought iron to-day in exactly the same way as it was made in the olden times after puddling was invented; that is, we puddle our iron from pig iron. As no doubt many of you know, pig iron is a cast iron, containing about 93 per cent. of pure iron. The rest is carbon, silicon, phosphorus, sulphur, etc. This pig iron is remelted in the puddling furnace (the fire chamber being separated from the melting chamber), the temperature in which is above the melting point of pig iron but below the melting point of wrought iron, and when the metal is in a molten state it is stirred up by the puddler and his helper, which causes the carbon in the iron to burn out, and as the particles of iron become purified, they partly congeal, *come to nature,* because the temperature of the furnace is not high enough to keep the pure iron liquid. The other impurities will separate from the iron, forming puddle cinder, in which the pure iron crystals float around, like sugar crystals in molasses in a vacuum pan. As more and more of these crystals congeal and come in contact with each other, they stick together, forming a spongy mass, the cavities of which are filled with liquid cinder, or, to make a homely comparison, it is like a popcorn ball, held together with molasses.

After removal from the furnace, this spongy mass is squeezed or hammered into blocks and then rolled out into bars. The cinder-coated globules of iron become elongated, giving wrought iron a fibrous structure, that is, the iron and the cinder coating get stretched out together, so that the latter is distributed through the whole body of the iron. This enclosed cinder plays a most important part in the resistance against corrosion. It consists of a silicate of iron, — an iron oxide with some silica; and because silicate of iron resists ordinary corrosive action better than pure iron, its presence in wrought iron is responsible for the fact that wrought iron resists corrosion better than steel, because the latter is a more homogeneous metal, without any enclosed cinder fibers.

Mr. Speller mentioned something about old wrought-iron pipe in use on the Panama Canal, which presumably had been furnished by the French many years ago, and which was still in good state of preservation, and he further stated that the pipe had probably been painted. Now, if a layer of paint can prolong the life of iron and steel, a fine layer or fibers of silicate of iron all through the body of the iron is also a resistance against corrosion, but, like most paint, it is only a resistance against mild corrosive influences, for if we pour acid on the paint we destroy its usefulness, and so it is with the protection afforded by the cinder in wrought iron. To illustrate this roughly, you can take several layers of blotting paper held tightly together with rubber bands. At one end between each layer of blotting paper place a layer of thin writing paper, to represent the cinder, while at the other end there is only the blotting paper, to represent the steel; or, to use the analogy of the popcorn ball, the blotting paper represents the corn and the writing paper the molasses. Now, if we pour an equal quantity of ink on the end representing the steel, the ink will penetrate several layers of the blotting paper, while at the other end the first layer of writing paper has practically arrested the penetration of the ink. If we take acid instead of ink, it is a different story, as the acid will go right through the writing paper as well as the blotting paper.

I am very much pleased to hear Professor Walker confirm our contention that acid tests are entirely unreliable as a guide to resistance against ordinary corrosion. It gives me great satisfaction to say this, because, when I made the same statement some years

ago at a meeting of the American Society for Testing Materials, some scientific gentlemen present disputed it. I believe, however, that those who have followed the discussion of this subject are now agreed that the accelerated corrosion tests are entirely unreliable and misleading.

While the protective action of the cinder fibers has been admitted, some scientific gentlemen have argued that there was not a sufficient amount of cinder in wrought iron. They had some microphotographs of wrought iron magnified seventeen diameters which showed only a few patches of cinder here and there; so they claimed this was like a picket fence that would let the wind (corrosion) blow through. Photographs magnified fifty, one hundred, and two hundred diameters, however, show that the picket fence has the pickets pretty close together.

Unfortunately, there have been some irons put on the market that are made by using old junk-yard scrap, heated up to a welding heat, *busheling or fagoting*, and then rolled out into bars, sheets, etc. When the old scrap consisted of nothing but wrought iron, it was not so bad, because wrought iron is permeated with the cinder fibers which were produced in the puddling operation, but junk-yard scrap nowadays is mixed with more or less steel, some of it, may be, high carbon or other alloy steel of various grades, and since steel is not permeated with cinder fibers, when these pieces get rolled into the iron, you have a starting point for corrosion or pitting. We fear that some of this kind of iron has been paraded as genuine wrought iron, and in some cases picked out when making comparisons with modern steel. Just as paint is a protection against corrosion on the outside of the metal, so the cinder fibers permeating wrought iron are a protection in the interior of the metal. In other words, a wrought-iron bar is like a wire rope of which every individual wire was painted before the rope was put together. The wires are the iron fibers and the paint is represented by the cinder fibers. Inasmuch as the method of making wrought iron by the puddling process is still the same as in vogue fifty or seventy-five years ago when puddling was first invented, and all the wrought iron used in our pipe is made that way, I do not see why it should not be just as resistant against corrosion as the iron which was made many years ago.

THE PRESIDENT. I am sure we have been very glad to hear how wrought-iron pipe is made, described in a way so graphic that we can all understand; and I am sure we are glad to know that it is made in the same way that it used to be made in the good old days. Mention has been made of the fact that users often do not know whether they are using wrought-iron pipe or steel pipe. Some of our members feel that there ought to be a way of marking pipe so that the mark could not be changed, and so that every user who knew the marks could see and know certainly what mill the pipe came from. I think it would be interesting if Mr. Schuhmann and Mr. Speller would tell us before they go whether they are willing to mark their pipe so that everybody will know when they get it, and if not, why not?

We have been hearing recently about a new kind of iron, not quite a steel, although made something like steel. Is there any one present to speak for this new product which has recently come upon the market?

MR. H. S. KAHURL. Mr. President, we expected to have here to-day a representative of the Harrisburg Rolling Mills Company of Harrisburg, who is interested in this pipe; but unfortunately he was detained in New York. I cannot personally say anything in regard to the qualities of this pipe, except that it is a new product that we have taken over and are going to sell in New England. Whether the sulphuric acid test which is spoken of is any good or not, I cannot say definitely. All I can say is that the American Rolling Mills Company of Middletown are putting out extensive advertising with the sulphuric acid test shown up on a little blue print. I can also say that a number of leading engineers of the country have endorsed that test. I see that the manufacturers of steel and of iron fall back on the argument of the long time that wrought iron and steel have been in use. As ours is a new product, we cannot, of course, bring forward any samples that have been in the ground as long as theirs.

THE PRESIDENT. Certainly it is nothing against a new product that it cannot show long experience. The subject is now open for general discussion and also for questions, because we have Mr. Schuhmann and Mr. Speller here especially so that you gentlemen may ask them all the questions you like.

MR. A. W. CUDDEBACK.* We do not use galvanized pipe any more; we have found it not satisfactory.

GEORGE SMITH, ESQ.† Mr. President, I am not a member of the Association, but I believe that Springfield was instrumental in getting this report from Professor Walker to-day. We had some serious trouble in Springfield with regard to water after our new supply was turned on to the city; and after the newspapers had complained of the plumbers and builders using poor material, we forwarded the report which referred to the use of steel pipe to the National Tube Company. Of course, we did not know whether it was using steel or wrought iron. We bought wrought iron sometimes and sometimes steel, but in each case we had the same trouble.

We also have the same trouble, I might say, wherever we use brass pipe. The red-water proposition is just the same. We have never been able to give the public of Springfield a satisfactory answer. A man comes into our place and asks us why he gets red water in his system, and we tell him so-and-so, but he does not believe us, simply because of the report, made, I believe, by Mr. Whipple, of the firm of Whipple & Hazen.

We would like to go back to Springfield with an answer from such a man as Professor Walker or Mr. Hazen or Mr. Speller, why we get red water in systems where we have brass pipe and copper boilers, just the same as we get it where we have iron and steel pipe and steel boilers. We asked the water department for help and they were very courteous in doing anything we asked them to do. They flushed the mains, getting out a great amount of substance which we had analyzed, and we also had analyzed the material which came from the service pipe and the boiler, and in each case it showed about ninety per cent. iron, according to Dr. Emerson, of Springfield, and about one half of one per cent. more from the service inside the building than outside.

The Springfield Master Plumbers Association is interested to have something to tell these people, when they come into their places of business, as to what causes the red water, and why we get it in systems where we have copper and brass pipe just the

* Engineer Passaic Water Company, Paterson, N. J.
† Of George Smith & Co., Springfield, Mass.

same as where we have iron pipe. Now, any information we can get on that point from Mr. Walker would be very welcome by us.

PROFESSOR WALKER. Mr. Smith very kindly handed me a list of questions just before the meeting, and I will now do what I can to answer them.

The first question is: "How do you account for the great amount of red hard substance taken out of the street main?" If the red hard substance is by analysis 90 per cent. iron oxide it means that it is ordinary rust. The other parts are doubtless material from the water itself. We will leave this question and come back to it later, because it really takes in all the remaining questions.

"How do you account for this substance taken from the street main containing about the same amount of iron rust as the substance which is taken from the service pipe and storage tank inside the building?" I think the only answer to this is that the material is from the same source; the fact that one is found in one place and the other found in another place simply means that there is one common source, and the material is carried therefrom to both places. I do not believe there can be any answer to this other than the one that the material comes largely from the street main, and is carried mechanically by the water into the service pipes.

"How do you account for the red-water trouble in buildings where the houses are piped with either brass or lead pipe and the storage tanks are copper?" Of course, it goes without saying that you can't get iron rust, which this red material is, from a copper tank or lead pipe or brass pipe. That requires no discussion. So the answer to this question also is that the red water must come from the iron mains. In other words, the rust is formed in the mains and is carried through the mains into the house systems.

"How do you account for the sudden change in condition since we have been using Little River water?" I am ignorant of the properties of the Little River water, and I really cannot talk about it with authority because I haven't the data. I would say without much hesitation, however, that some of the factors that we have discussed here this afternoon have been intensified in the Little River water. I believe that this matter can be solved. I do not

think that the city of Springfield should lie down and suffer from red water until they know what the cause of it is; but I am not prepared to say now what the cause may be, because I have never made a study of the conditions.

" Can you tell us why it is that steel and wrought-iron pipe can be used in the city of Holyoke, which is only eight miles from Springfield, while this same pipe cannot be used in Springfield? "

The answer to that is, of course, that the conditions which obtain in Springfield do not obtain in Holyoke, therefore it must be possible to determine these conditions. I cannot now say what they are, but it must be possible to find out.

Now, coming back to the first question, " How do you account for the great amount of red hard substance taken out of the street main? " You account for it by some intensified condition of corrosion in the water. Assuming it to be true that Holyoke uses steel and iron pipe and the same water that Springfield does, and Holyoke is free from this trouble, while it is so intensified in Springfield, the trouble must be due to some difference in the local treatment or conditions. Just what these differences are can be determined only by an investigation.

Let me say, in reply to Mr. Hazen's remark, that apparently the only remedies which one can apply to water to save the pipe are those which kill the water; that it is a good deal like the old man who thought he could teach his horse to eat sawdust; the moment the horse got so he could eat sawdust, he died. You cannot put in lime, I realize that, however efficient that would be; and you cannot have too much organic matter, because you want pure water; but you can, if necessary, take the oxygen out.

I don't know whether you have followed the very important work that is being done in Australia, where there is a very expensive steel or iron aqueduct which is corroding badly. The reason why it corrodes badly is because they have such a very pure water. Mr. Hazen is right in saying that the purest water is the worst water on pipes. You will find in a boiler plant which being supplied with a spring water that is absolutely pure that the pitting and corrosion is enormous. We had a case of this kind from Cape Breton; the water used for the boiler plant was exceptionally pure and the boilers were pitting very badly. The trouble

was that there was nothing in the water to coat the pipes over, that is, to make any boiler scale. The water was saturated with oxygen, and, therefore, corrosion was rapid. The difficulty was overcome entirely by putting in open pre-heaters where the oxygen was boiled out of the water before it went into the boilers. The trouble absolutely and entirely disappeared, as it must have, because without the oxygen you cannot get corrosion.

They are doing the same thing in Australia, namely, putting in an elaborate system to take the oxygen out of the water. I do not know that we can do that, except in apartment houses. I do believe it is possible there, and it may be the solution to which we will have to come. It will not spoil the water for drinking purposes. Taking the oxygen out is not in any way, so far as I know, and I think I am right in this, depleting the water of any of its valuable constituents.

MR. DEXTER BRACKETT.* The service pipes used in the cities and towns comprising the Metropolitan Water District are generally of lead, but wrought-iron pipes, both plain and galvanized and lined with cement and lead, have been and are still used. Lead service pipes have been almost universally used in Boston since the introduction of water from Lake Cochituate in 1848. Investigations made at that time showed that the action of Cochituate water on lead in a few days forms a coating which for all practical purposes is impervious to water, and that the water can be served from lead pipes connected with iron mains without detriment to health.

Regarding the life of wrought-iron pipes, it is well known that pipes made of thin sheets of wrought iron, lined and covered with cement, were extensively used in distribution systems in this vicinity from forty to fifty years ago, and also that in most cases these pipes failed after from fifteen to twenty-five years' use and have been replaced by pipes of cast iron. There are, however, instances where the work was well done, and the pipe was not tapped for house services, in which the life of this pipe was much prolonged.

There is in use on the Metropolitan Works a 30-in. wrought-iron cement-lined main about two miles in length which has been in

* Chief Engineer, Metropolitan Water Works, Boston.

constant service for forty years and is still apparently in good condition.

The speaker has in his office a section of pipe 5 in. in interior diameter, bored through a wooden log, which was laid by the Jamaica Pond Aqueduct Company about one hundred and ten years ago and was used for at least fifty years for conveying water to the city of Boston from Jamaica Pond. The large end of this log or pipe is encircled by a wrought-iron ring 10 in. in diameter, $1\frac{1}{2}$ in. wide, $\frac{1}{4}$ in. thick on one side and brought to a sharp edge on the other. This ring, which was buried in the ground and exposed to moisture for one hundred years, is, so far as can be judged, in substantially as good condition as on the day it was made. It appears very doubtful whether it would be in its present condition if made of steel.

An example of the preservation of wrought iron, which the speaker attributes to the cutting off of the supply of oxygen, is the perfect condition of wrought-iron bolts in a submerged pipe line after having been buried for fifty years under the mud bottom of Boston Harbor.

THE PRESIDENT. There is sometimes trouble in the use of lead pipe, I understand, in services. Will Mr. Thomas tell us what the conditions are in Lowell as regards his service pipes?

MR. ROBERT J. THOMAS. Mr. President, our trouble with lead pipes at Lowell has not been due to the lead, but to the clogging up of the pipe due to the water containing a large amount of crenothrix, unless you are referring to the time some years ago when we were warned that the water acting upon the pipe absorbed the lead so that lead poisoning was caused. That, of course, is simply following out what Dr. Walker said, that all these metals are more or less soluble in water, and the water in that case in Lowell acted upon the lead pipe. It also acts upon iron to some extent. We have used some galvanized pipe, but without any special advantage so far as we could notice in the results. The pipe which has given us the best results is tin-lined pipe. We have found by experiments that the water acts less upon tin than upon any of the other metals which we could use for pipe.

THE PRESIDENT. What material do you generally use for service pipes now?

MR. THOMAS. It is a tin-lined iron pipe. That is, I presume it is iron pipe; it may be steel.

MR. EDWIN C. BROOKS.* Mr. President, I might say in regard to steel pipe, that I find that the weld, where the pipe is butt-welded, is apt to be so hard that it is very severe on the dies, and we found it was hard to cut clean threads on many pieces of steel pipe on that account. I would like to ask Mr. Speller if it is possible that any hardening could take place in the butt-welding of steel pipe? We certainly have had a good deal of trouble from that cause, and we are now using wrought-iron pipe.

MR. SPELLER. I think you will find the trouble — if there is any trouble with the threading — is on account of not having a good die. The steel is somewhat harder to thread than iron, but you will not notice it if the die is properly shaped. What you refer to as hardness at the weld may be a slight depression at the weld, which will cause the tooth of the die to catch. When you speak of hardness in steel pipe it usually means toughness.

MR. BROOKS. I have been too long in the business to have tools of the kind you suggest. What I speak of is hardness. The dies that we use are from a reputable firm in Boston. I think you would find it hard to maintain that their dies were not suitable. We found a hardness in the weld; that is, when you tried it with a file it would seem as if it had been actually tempered along the line of the weld. Now, whether anything occurred at that point to tend to harden the steel more than at another point, I do not know; but the trouble was certainly a real trouble and not a fancied one.

MR. SPELLER. I have never had any experience with such cases as that, and when I was speaking a moment ago, I was referring to other instances that seemed to correspond with yours. This is the first time I have ever heard of a piece of pipe steel being what you would call hard at the weld. If it is genuine pipe steel it cannot be hard, or we could not weld it. It is one of the purest forms of iron made. It has no tempering quality whatever. You can forge it and chill it in water without hardening in the least. If you have any cases like that on hand we would certainly like to see them.

MR. BROOKS. We discontinued using steel for the very reason

* Superintendent Water Works, Cambridge, Mass.

that there was so much complaint made of the hardness on this line running through lengthwise of the pipe, where the weld was; and it occurred to me whether there might be any possible reason for that in the manufacture.

THE PRESIDENT. Perhaps that wasn't Mr. Speller's pipe, Mr. Brooks. If he had put his name on it you would have known with certainty.

MR. RICHARD A. HALE.* In connection with the water-power development at Lawrence in the earlier days, wrought iron was used as material for the penstocks, the diameters of which varied from 6 to 9 ft. In the last two or three years some changes were made, involving the installing of new wheels, and necessitating a cutting off of the lower portion of some of the penstock. In one mill there was a penstock,I think, 8 ft. in diameter, of wrought iron, which had been in for forty-five years, and an examination of it, where it was cut off, showed no deterioration of the iron that was visible in any way whatever. The iron was bright; there was no pitting. The penstock had been preserved by painting with red lead from time to time when the water was out. There was no pitting either on the inside or on the outside, and no reduction in thickness.

During the last twenty or twenty-five years steel plates have been used for penstocks instead of wrought iron, and observation from year to year of the surface of the interior has shown no indications of marked deterioration. In some cases, where the coating of asphalt has worn off, or whatever paint was put on, there have been some tubercles formed and a slight pitting, but not to any depth; the outside of the penstock does not show that any changes have occurred where it could be examined.

As far as we have seen, there has been no great difference between the steel and the wrought iron. The principal trouble with a steel penstock, and with all penstocks, is to find a proper coating to prevent the water from corroding the interior. Certainly wrought iron, after an experience of forty-five years, has been found to be in excellent condition.

Mr. Brackett speaking of the ring reminded me that recently we took out a wooden penstock, which had been in about fifty

* Principal Assistant Engineer, Essex County, Lawrence, Mass.

years, with iron bands on the outside about an inch and a half to two inches in width and half an inch in thickness, and the wrought iron shows excellent condition, with a bright and fibrous texture, although no coating had been put on. A chemical examination showed a very excellent grade of wrought iron. In all of these cases there were no electrical currents in the vicinity which would produce electrolysis.

Mr. William F. Sullivan.* Our experience with so-called galvanized wrought-iron pipe has shown that the average life of 1-in. pipe is from twenty to twenty-five years, and of $\frac{3}{4}$-in. pipe from fourteen to twenty years, — that is, before it fills so that the service has to be renewed. We find after the filled up pipe is placed in the " scrap " the matter that blocked the flow of water dries and can be knocked or shocked from the interior of the pipe by the aid of a scraper. The old pipe is generally in good condition and may be disposed of as second-hand pipe for about one quarter the cost of new pipe. The users of this second-hand pipe are generally farmers or campers.

We find that the cost of renewing services is inexpensive, owing to the low first cost of the pipe and the character of the excavation — in many instances we are able to drive new services without much trenching. We find that the galvanizing wears off the pipe in a few years, but we feel satisfied that it is worth the slight difference in cost to use galvanized iron pipe. We are not always absolutely certain whether we get the genuine wrought-iron or steel pipe, and as far as my experience goes, it never has seemed of great importance to us on account of the periodic filling up of service pipes.

Mr. George A. Stacy.† I have had about the same experience as that of Mr. Brooks with regard to temper in steel pipe. I don't know about the life of iron or steel, but I think that the dies will last longer on wrought-iron than they will on steel pipe.

The reason I have adopted wrought-iron pipe is because as a general thing when you go into the market you get heavier stock, you get stock that works easier, and it runs more even. We do find that some steel pipe, or pipe which comes to us as steel, is

* Superintendent Pennichuck Water Works, Nashua, N. H.
† Superintendent Water Works, Marlboro, Mass.

much harder and affects the die much more than wrought-iron pipe does. Of course, a dull die is not a very pleasant thing to work with when you want to cut a good thread on anything; but when you get a dull die on a piece of hard steel pipe you have a pretty tough proposition.

I don't condemn steel pipe; I don't know anything about the life of it; but if we have two pieces of pipe, and the pitting is equal, then the light pipe is going first.

Up to the present time my experience with wrought-iron pipe has been every way much more satisfactory than that with steel.

Mr. F. N. Connet. I have not had experience with steel pipe, Mr. President, but there is one question I would like to ask Professor Walker. Some years ago the New York Edison Company had considerable trouble from the depositing of a red material in their boiler feed system, and analysis proved it to be oxide of iron. They used surface condensers, and consequently the same water was used over and over again and no additional oxygen could get into the system. They had been using a small percentage of animal oil in their lubricating oil, and they decided to change over and use mineral oil entirely, after which this trouble ceased.

The explanation which was offered was that a catalytic action had taken place due to the oleic acid present in the animal oil. The idea is that a certain amount of oxygen was absorbed by the oleic acid from the oxide of iron and this was afterward released so that it could immediately combine with more iron and be converted again into oxide of iron, which process could be repeated indefinitely without the necessity of constant renewal of oxygen from outside.

Whether or not this explanation is the correct one, it is certain that when the use of animal oil was discontinued the trouble disappeared. Their feed pipes were four or five inches in diameter and some were the cast iron, some wrought iron, and some cast steel.

Professor Walker. With regard to the word " catalytic," I think that engineer was probably doing as a good many of us do, — when we strike something we don't understand we call it " catalytic action." I don't think it was catalytic action; nor do I think oxide of iron will give up its oxygen when once formed. On any steam heating system which has been running in a closed

cycle for a good while, when you open a radiator pet cock not infrequently you will get enough hydrogen to burn. That is due to the presence of carbonic acid gas in the system. This gas passes up with the steam and is absorbed by the condensed water, forming an acid solution. This reacts on the iron pipe, forming soluble iron carbonate. This returns to the boiler and under the heat there decomposes into iron oxide and sets free carbon dioxide again. I have never heard of, nor do I believe you can have, a cycle in which oxygen acts in this way; when oxygen is taken up by iron it stays combined.

I think it is a fact without question that the animal oil does form free acid when heated with water to a high temperature, and this in itself accelerates corrosion.

Didn't they use any makeup water at all?

MR. CONNET. A very slight percentage.

PROFESSOR WALKER. A possible explanation is, I think, that they were taking some air into their vacuum system. If you are getting an accumulation of iron oxide it means you are getting additional oxygen. There is no possible escape from that conclusion. Where that oxygen is coming from may be a question. But if they use no makeup water and if their system is closed, that is, if they have no expansion tank, my suggestion would be to look for an air leakage somewhere; because if you use up the oxygen in uniting with the iron at one place, I don't believe that this oxygen can ever get free to unite with any other iron. So I think that the animal oil was the active agent in intensifying the corrosion, but it must have gotten oxygen from somewhere to unite with, in order to form the iron rust.

THE PRESIDENT. I am going to ask Mr. Schuhmann and Mr. Speller to answer with regard to the various points which have been made, as far as they can, and I also want them to give us their point of view on this question of marking their pipe, so we can know what pipe we are using. I am also going to ask them if they will not tell us something more about galvanizing and the methods of galvanizing which are used. Dr. Walker has emphasized the importance of having an absolutely uninterrupted coating of zinc, — I don't remember that he mentioned the thickness of it, — but there is a prevalent impression that galvanizing has been

done in the last few years in a very economical manner. I think the members of the Association would like to learn what they can about that.

MR. SCHUHMANN. In regard to galvanizing, it is the same thing as with the manufacture of wrought iron, that is, the old way is the best. We have been approached by different inventors who would claim that they could save us anywhere from $3.00 to $5.00 per ton by using their processes, but since the cost of labor is less than 10 per cent. of the cost of galvanizing, while the cost of zinc (spelter) is over 80 per cent., then such a great saving could only be effected by reducing the amount of zinc used, which means a reduction in the thickness of the coating, and for that reason we have declined all such offers, as we do not want to cheapen the goods at the expense of quality. We told these gentlemen that if they could bring us something that would make galvanizing better, we would consider it.

We are using the old process known as the "hot-metal process." The pipes are first pickled in a bath of dilute sulphuric acid, which removes grease, scale, etc. Then they are put in a tank of water to wash off the acid, and after that, put into another tank of dilute muriatic acid. After removal from this tank, the muriatic acid is allowed to dry on the pipes. They are then laid on top of the galvanizing kettle for a short period, to pre-heat them, and are then immersed in the molten zinc in a kettle containing about 60 000 lb. of this metal. They are allowed to remain in there long enough to get the same temperature as the molten zinc, and are then pulled out and held in an inclined position to allow the molten zinc to run out of the inside. Owing to the fact that wrought iron has a rougher surface than steel, the zine coating will stick to it better and in thicker layers, so that you have not only a better metal as a base, but a heavier coating in addition.

I want to make a few remarks about the statements made by some of the gentlemen in reference to variation in the hardness of steel pipe, and in order to explain that I will have to give a little description of the manufacture of steel. Steel is generally manufactured in large quantities. They make about 15 tons at a blow of a Bessemer converter and anywhere from 25 to 50 tons at one heat of an open-hearth furnace. After the purification is com-

pleted, the steel is poured into large ladles and from them into large ingot molds, forming the so-called "ingots." After it is poured into ingots, the steel melter has finished his work. He cannot do any more to it. But the metal is too hot yet to permit rolling out. It must be allowed to cool first, and during this process of cooling some of the impurities still left in the steel will flock together in the liquid mass, which is technically known as "segregation." This has been fully discussed in some papers before the American Society for Testing Materials, and tests made with large steel boiler plates, by marking them off in squares like a large chess board and taking samples of the different squares, show large variations in the chemical composition as well as physical qualities. So, while it is possible to have hard and soft steel pipe made out of the same ingot, it is also possible that one end of a pipe may be soft, while the other end of the same pipe may be much harder.

Wrought iron is made in small quantities, about half a ton at a time, four men working alternately for about an hour and a half stirring it up so as to thoroughly purify the metal, and in that way the pure iron and the cinder become thoroughly mixed. After the puddle bars have been rolled out, they are cut up into shorter pieces and piled on top of each other, like bricks in a wall. This mixes the iron up similar to the way they mix salt-water taffy with the mixing machines, and the resulting product is of much more uniform quality, just as practical experience has demonstrated. We have not learned of anything yet by which the segregation of steel during the process of cooling can be prevented. Professor Stoughton states that segregated steel will corrode much faster than the same metal in which the impurities are evenly distributed, and he further qualifies the statement by saying that this segregation is always present to some extent in Bessemer and open-hearth steel, and that it is practically unknown in wrought iron.

In regard to the question asked by the President about marking the pipe, would say that we are making experiments with that now, but find it is not as easy as rolling the name in steel rails, for instance. We have tried one way by setting steel dies into the rolls, projecting slightly, so as to roll the name into the pipe. This makes a fairly good mark in black pipe, but after being galvanized

it nearly all disappears again. If the impression is made too deep, then by cutting the pipe right where the name is, it may cause defective threads and consequently a leak. On the other hand, making the impression in the rolls so that the name will project outside the pipe, the planishing rolls will deface it again, or, if left too high, it may require filing off to cut threads. As stated above, we are still experimenting, and hope that before long we will be able to mark our pipe distinctly, because we are not ashamed to put our name on it.

If I understand Professor Walker's statement correctly, he bases his conclusion that there is no material difference between the corrosion of wrought-iron pipe and steel pipe on calculations made by measuring the depth of corrosion on partly corroded pipes under observation for a given time, and also on his erroneous assumption that the corrosion of both metals would have continued at the same ratio at which it started. A large number of tests made by other experimenters have proved that the corrosion of iron and steel is very irregular and erratic. Professor Stoughton, in his article on this subject in the *Engineering Magazine* of July, 1911, states that the rusting of some parts of a piece of steel will be more rapid than of other parts at first, and then conditions may change and the reverse will be the case. Moreover, some specimens will rust more rapidly than others at first and then more slowly. Professor Howe, in a similar paper read before the American Society for Testing Materials (Vol. 6, page 150), gives some very plausible theories as to why corrosion is not uniformly progressive. Such being the case, we feel that conclusions based on calculations of the supposed life of the pipes, by making micrometer measurements of the depth of partial corrosions, are as unreliable as accelerated corrosion tests, which, as we know, are entirely misleading. Fortunately, we have other tests, based on many years of actual experience under ordinary service conditions with wrought iron and steel pipe miles in length, weighing thousands of tons, and where corrosion continued until the holes penetrated the metal, and in all such cases of which a record has been kept the wrought iron was so far superior that it did not require calculations based on measurements to prove the greater durability of wrought iron under average service conditions.

In reference to the remarks made by the gentleman from Springfield, that no matter whether they used wrought-iron or steel pipe for service pipes, the water still retained its red discoloration, and assuming Professor Walker's explanation as correct, that the trouble was in the main, then it is but natural that the material out of which the service pipes were made had no influence on same, for if they had been made of glass it would not have changed the color of the water supplied by the mains.

MR. SPELLER. It is hardly necessary to say anything more about galvanizing, as Mr. Schuhmann clearly described the method we are using, that is, the old process of hot galvanizing. Many improvements have been suggested, but any process which promises a reduction in the amount of zinc applied to the surface must be considered with suspicion. No wiping operation should be permitted on galvanized pipe, as it is of the first importance to retain on the surface as much zinc as possible.

Most of the criticisms on steel pipe this afternoon have been on the matter of threading. This has been a surprise to me, as we have not heard much about this trouble of late years. Steel pipe as made direct from the ingot is softer, but at the same time tougher than wrought iron, and, therefore, slightly harder to thread, unless the dies are made with somewhat more rake and clearance than was the case when nothing but wrought-iron pipe was used. Most of the good dies on the market are now properly shaped, and will thread either iron or steel pipe without trouble. We have made a good deal of iron pipe in our time, and now that we are making nothing but soft steel pipe our threading practice is very much better. Fewer bad threads occur, and the speed of cutting has been increased,with a proportional economy in practice. You will find a properly cut thread on steel pipe is stronger and cleaner than can be made on wrought-iron pipe on account of the more homogeneous character of the metal.

Regarding the reference to hard spots in pipe, it would not surprise any one familiar with pipe business if the instance of this referred to turned out on examination to be the kind of wrought-iron pipe our friend Mr. Schuhmann was describing as being made of miscellaneous steel scrap. When steel scrap is bought for the manufacture of wrought-iron pipe (so called) it is impossible to be

sure of its character, and consequently an occasional hard piece is likely to be worked in with the pipe. When steel is made for the manufacture of pipe exclusively, and rolled direct from the ingot, this cannot happen, for if the metal was not uniform or hard in places it would not weld, and would be a loss to the manufacturer. Moreover, no carbon additions are made to steel manufactured for pipe. The iron is refined to the lowest point and is relatively so low in carbon that segregation, if it does occur, can do no harm. So the remedy against possible hard spots is to purchase from the concerns who have control of their raw materials, and who can give satisfactory assurance that sound and uniform metal is put into their product. One important advantage which the steel pipe manufacturer has, where he is making pipe steel exclusively, is, that the product of the steel works is in the hands of a crew of trained experts who can be held responsible for the entire output as to quality. In making puddled iron, on the other hand, with the responsibility divided among a large number of puddlers, the same control is not possible, each man being a law unto himself within rather broad limits. Furthermore, we can speak from our own experience that it is no easy matter to recruit the ranks of the old-time puddlers, as the younger men are inclined to choose a less strenuous job where their skill can be used to better personal advantage.

As to the question of weight and thickness, that is entirely in the hands of the consumer. Steel pipe is now used for such a variety of purposes that it has been found necessary to make more than one standard weight for the same size, and this is also true of wrought iron to a certain extent. By specifying the weight required, and allowing a reasonable margin above or below for variation in manufacture, there should be no trouble in this respect.

Regarding the question of marking pipe with the name of the manufacturer: we have been in the practice of rolling our name on all lap-weld pipe for some time. It is comparatively easy to do this on lap-welded pipe where there is a mandrel on the inside to support the metal. However, marking butt-welded pipe where no mandrel is used is quite another matter. Most users of pipe naturally object to a depression being stamped in the surface, and some also object to having the raised letters on the pipe. I am

glad to say we now have a process for rolling letters in relief on butt-welded pipe which will soon be put into practice so that the consumer may know that he is getting genuine steel pipe, made under a process which insures a maximum of uniformity and durability. By this system of marking it will be impossible to confuse this pipe with that made from steel scrap — or wrought iron.

THE PRESIDENT. Professor Walker, the Association is much indebted to you for coming here this afternoon and for explaining the nature of corrosion so clearly. Mr. Speller is a member of the Association, and I believe the Association has a rule that its members are not to be thanked; but I am sure we have appreciated his being here and doing his duty. Mr. Schuhmann, I think I voice the sentiment of the Association when I thank you for coming here to-day and telling us so much about your pipe and the method of its manufacture, and answering the questions which have been asked concerning it.

MR. RAYMOND W. PARLIN * (*by letter*). Mr. Albert Heard, superintendent and manager of the Washington County Water Company, states that that company completed its water works in July, 1882, at which time it began using one and one-half inch cast-iron B. &. S. pipe for services.

In 1887, after having had considerable trouble with the lead joints in the said pipes, they changed to one-inch extra heavy galvanized genuine wrought-iron pipe and have used the same since with good results. The character of the soil is red clay and lime stone. Some of this style of services have been in since 1882 and are to-day apparently in good condition.

The only trouble they have had is in some cases where the gutter was put in with a base of coal ashes or cinders, in which case the dampness percolating through them causes the pipe to corrode and to eat through for a short distance directly under the cinders, while the pipe on each side of the place has the galvanizing on it intact.

From a superficial examination it would appear that the trouble is caused by the galvanic action set up between the iron and the zinc by contact with the dilute acid from the cinders.

There are about 3 200 services, of which at least 2 400 are of galvanized pipe, and replacements do not average six a year.

* Resident Engineer, Washington County Water Company, Hagerstown, Md.

MR. SPELLER (*by letter*). Mr. Schuhmann in referring to conclusions reached from the many comparisons of iron and steel cited has failed to note that the samples were taken from pipe showing all stages of corrosion. (See average depth of pitting, Table 1, page 17.) The experience showed that the same comparisons obtained whether the corrosion was comparatively light or otherwise. In some cases the samples were taken from pipe which had been pitted through.

The depth of the deepest pits were taken in order to have some basis of comparison. No calculations or assumptions were made, nor was there any necessity for such, as we are here dealing with simple facts from specific experiences.

It is only lately that such comparisons could be looked for, as steel pipe is a comparatively modern product, and whatever the merits of the wrought iron prior to the advent of steel pipe, it is surely of more concern to know how steel pipe stands up compared with wrought iron made in our time where both were put in service together, under conditions which have prevailed during the past ten or fifteen years.

PROFESSOR WALKER (*by letter*). It is evident from what Mr. Schuhmann says (page 34) that he did not understand the nature of the investigation which was conducted or the basis of the conclusion arrived at. Mr. Schuhmann mentions "his [Walker's] erroneous assumption that the corrosion of both metals would have continued at the same ratio at which it started," and then discusses the test as though the samples of pipe had been submerged in water for a few weeks or months. He is right in stating that a short time exposure is an unreliable basis from which to draw a conclusion; but such was here not the case. The pipe examined had been in service from two to seventeen years and the condition after long service is what is reported on, not a short laboratory test such as Mr. Schuhmann cites. As an indication of the condition of the pipe, not as a "calculation," as Mr. Schuhmann assumes, I give the measurement of those samples of pipe which were rusted to practical destruction, that is, where either the iron or the steel showed pits over one tenth of an inch in depth.

TABLE 2.

Sample — Number.	Depth of Pitting.		
	Mean of Ten Deepest Pits.	Deepest Pit.	Least of Ten Deepest Pits.
	Inches.	Inches.	Inches.
W-10 — Iron	.102	.134	.085
W-11 — Steel	.075	.095	.067
W-22 — Iron	.114	.160	.068
W-23 — Steel	.075	.107	.042
W-24 — Iron	.139	.168	.109
W-25 — Steel	.140	.204	.076
X-15 — Iron	.077	.101	.069
X-16 — Steel	.040	.047	.034
X-29 — Iron	.042	.060	.030
X-30 — Steel	.066	.103	.042
X-49 — Iron	.077	.113	.049
X-50 — Steel	.071	.122	.040
X-57 — Iron	.038	.110	.012
X-58 — Steel	.026	.053	.012
X-69 — Iron	.113	.159	.032
X-70 — Steel	.119	.177	.095
X-71 — Iron	.115	.169	.063
X-72 — Steel	.075	.156	.045

SOME THINGS DOMESTIC METERS DO NOT ACCOMPLISH.

BY WILLIAM S. JOHNSON.

[*Read February 14, 1912.*]

Five years ago it was the writer's privilege to present to this Association some facts relating to the consumption of water and the use of meters,* the chief object of the paper being to emphasize the fact that the use of domestic meters does not necessarily mean a low rate of consumption and the lack of meters a high rate, but that there are other conditions which have in many cases a greater influence on the quantity of water used and wasted than the method of charging for it.

In connection with the paper, statistics were presented, including all of the records which could be obtained, some of which showed results quite different from those commonly quoted to show what meters will accomplish. The discussion which followed seemed to indicate that if the figures did not show low consumption with the use of meters, the figures must be wrong.

Since this paper was presented I have had occasion to analyze the consumption of water in several towns, and interesting facts from other places have come to my attention showing even more clearly than the results presented five years ago some of the things which domestic meters do not accomplish, and showing also that any intelligent discussion of the probable saving of water by the introduction of meters should be preceded by a study of the conditions in the town to be metered.

It is very common now to find in a town suffering from a shortage of water, a number of enthusiasts who earnestly believe that the only thing needful is to introduce meters and thus solve the problem of a future water supply by reducing the consumption. The cities of Brockton and Fall River, with a consumption of about 40 gal. per person per day, are invariably cited as examples of

*JOURNAL, N. E. W. W. A., Vol. 21, p. 109.

what can be done in any municipality by the introduction of meters.

In many of these places a study of the conditions shows that any such reduction of the consumption is absolutely impossible. A good example of this is the case of a Massachusetts town where there are perhaps 20 or 25 meters in use, and where there has been a lively agitation for the introduction of meters to relieve the shortage of water. Ten of the consumers already metered use for manufacturing or mechanical purposes enough water to make the average daily consumption in the town 35 gal. per person. The placing of meters upon all of the other 800 or 1 000 service pipes would undoubtedly reduce the consumption of water to some extent, but this town could never be in a class with Brockton, with its consumption of less than 40 gal. per person per day.

Other factors than the use of water for manufacturing purposes, some not so obvious, are almost universally overlooked. The stealing of water from fire-service supplies; leakage from mains and service pipes; and water used for flushing sewers, for drinking fountains, and other public purposes, are large items in the consumption of water, and the finding of one leak or of one case of stealing water may reduce the consumption more than the installation of hundreds of domestic meters.

As far as the saving of water is concerned, if I could not have both, I would choose every time to have some means of measuring the whole supply rather than to have every domestic service provided with a meter. The results accomplished at Holyoke, Southbridge, and other places when it was discovered by means of meters on the main pipes how much water was being used, show what can be accomplished by simply learning the necessity of doing something and having the encouragement of seeing the results of one's labors recorded on the meter chart.

Of course, in pumping systems this does not apply, for an idea can always be obtained — though sometimes a crude one — of the amount of water used by the counter on the pump.

I want to say that I believe most thoroughly in meters, and consider that the only proper way to sell water is by measure, and in calling attention to some of the things which meters do not accomplish I do it as an ardent " meter-man."

Meters do not prevent an increase in the quantity of water used for what may be termed legitimate purposes. This increase in the use of water, which has been referred to many times, is due chiefly to the increase in the number of plumbing fixtures, especially in the less expensive houses, and the increased quantity of water used in the modern fixtures. The rate of increase may be somewhat affected by the use of meters, but only to a slight extent, for householders are not likely to be deterred from the introduction of plumbing fixtures by the fact that the water is paid for by measure. In fact, the increased cost due to additional plumbing fixtures is generally less with meters than it is under fixtures rates.

This natural increase in use of water for domestic purposes is best shown in those places which have been thoroughly metered for many years and where there have been no great demands for water for manufacturing purposes. The increase in the per capita consumption at Brockton, which has been thoroughly metered for many years, was, between 1900 and 1910, 34 per cent. The increase in Fall River, another thoroughly metered city, during the same period, was 22 per cent. In North Attleboro, where all services are metered, the increase was 44 per cent. In Wellesley the increase in that time was 30 per cent., and in Worcester it was 7 per cent.

Comparing the increase in the ten-year period in these places thoroughly metered with places which have very few meters, it will be seen that, although the per capita consumption is generally larger, the percentage of increase is much the same. In Beverly, where only 4 per cent. of the services are metered, the increase was 26 per cent.; in Salem, 20 per cent.; in Danvers, 24 per cent., and in Newburyport, 63 per cent.

There are some unmetered towns in which the increase has been more rapid, such as Peabody, where the consumption increased 87 per cent., due largely to an increased use for manufacturing; but there are also unmetered towns where there has been a considerable decrease, such as Gardner, with a decrease of 34 per cent. in ten years, the reason for which will be given later.

To show the immediate effect of introducing meters the following table has been prepared in which the different cities and towns of Massachusetts, for which records of the consumption are avail-

able, have been grouped according to the increase in the percentage of services metered during the ten-year period from 1900 to 1910, and in the five-year period from 1905 to 1910, and the average increase in the consumption in each group has been obtained.

TABLE 1.

Increase in the Percentage of Services Metered.	From 1900 to 1910.		From 1905 to 1910.	
	Number of Places.	Increase in the Daily Consumption per Person (Gallons).	Number of Places.	Increase in the Daily Consumption per Person (Gallons).
Less than 10.....	24	15	44	6
From 10 to 25.....	14	11	16	1
More than 25.....	15	8	18	—11

Meters will never make the consumption in two places the same if the character of the population in respect to their requirements for water are different. Manchester, with all services metered, uses 120 gal. per person per day; Dedham, 129 gal.; and Beverly, with 4 per cent. metered, uses 91 gal. per person per day. These places with large estates owned by wealthy men and with sprinklers in operation continuously during the summer on extensive lawns cannot be expected to have a consumption like that at Fall River, and yet in one of these places I have heard Fall River cited as an example of what might be accomplished there by the general introduction of meters.

In many places one of the reasons why domestic meters will not produce a low rate of consumption is that there is a large quantity of water used for manufacturing or mechanical purposes.

Table 2 gives statistics in regard to the consumption by large consumers in various places in Massachusetts.

Even in the so-called unmetered towns the water used for manufacturing purposes is generally metered and it is easy to determine this element in the consumption, which in many cases is an important one.

TABLE 2.

City or Town.	Population 1910.	Average Daily Consumption per Inhabitant.	Largest Single Consumer Uses:—		Ten Largest Consumers Use:—		Twenty Largest Consumers Use:—	
			Per Cent. of Total Consumption.	Gallons per Day per Inhabitant.	Per Cent. of Total Consumption.	Gallons per Day per Inhabitant.	Per Cent. of Total Consumption.	Gallons per Day per Inhabitant.
Amherst	5 112	..	...	13.7	...	34.4	...	...
Attleboro	16 215	54	2.2	1.2	7.5	4.1	9.6	5.2
Billerica	2 789	39	8.8	3.4	17.8	7.0	20.4	8.0
Brockton	56 878	39	2.0	0.8	8.2	3.2	10.9	4.3
Chelsea	32 452	87	...	...	...	...	21.1	18.4
Chicopee	25 401	..	...	2.7	...	11.2	...	12.5
Clinton	13 075	45	7.3	3.3	22.4	10.2	26.0	11.8
Framingham	12 948	48	11.3	5.5	23.8	11.5	27.2	13.2
Franklin	5 641	61	8.8	5.3	23.4	14.2	26.0	15.8
Gardner	14 699	44	2.4	1.1	10.9	4.8	13.2	5.8
Gloucester	24 398	55	2.5	1.4	9.0	5.0	10.5	5.8
Greenfield	10 427	..	...	27.7	...	40.7	...	46.0
Haverhill	44 115	..	...	3.5	...	7.1	...	8.2
Holyoke	57 730	103	1.1	1.2	7.8	8.1	12.0	12.4
Lawrence	85 892	45	5.6	2.5	14.7	6.6	16.8	7.6
Leominster	17 580	..	...	10.7	...	34.4	...	42.3
Lowell	106 294	51	2.2	1.1	5.2	2.7	6.6	3.4
Lynn and Saugus	97 383	72	5.5	4.0	11.2	8.1	12.4	9.0
Malden	44 404	42	3.2	1.3	10.4	4.4	12.1	5.1

Marlboro.....	14 579	37	4.5	1.7	17.9	6.7	21.1	7.8
Middleboro.....	8 214	42	32.0	13.3	37.7	15.7	39.3	16.3
Milford.....	13 055	51	...	1.0	...	5.0	...	6.9
Milton.....	7 924	39	1.5	0.6	6.2	2.4	8.8	3.4
Monson.....	4 758	..	...	1.5	...	...	...	3.3*
Natick.....	9 866	57	12.2	1.3	9.4	5.4	12.6	7.2
New Bedford....	96 652	81	2.5	2.1	15.4	12.5	24.0	19.5
Northampton....	19 431	..	...	6.7	...	21.9	...	24.7
Reading.....	5 818	35	2.2	0.8	8.7	3.1	10.2	3.6
Springfield.....	88 926	..	...	1.9	...	9.1	...	12.7
Taunton.....	34 259	63	7.8	4.9	24.4	15.3	26.1	16.4
Weston.....	2 106	50	2.2	1.1	13.6	6.8	...	...
Winchendon.....	5 678	30	1.5	0.5	8.3	2.5	10.4	3.2
Worcester.....	145 986	74	...	...	...	...	19.3*	14.3*

*Total quantity used for manufacturing.

In the town of Peabody, for example, where only 7 per cent. of the services are metered, and the meters are placed only on the large consumers, the average daily consumption amounts to 152 gal. per person, and of this 64 per cent. is passed through the few meters. This amounts to 97 gal. per inhabitant per day.

In the town of Greenfield the quantity of water used by twenty of the large consumers amounts to 46 gal. per inhabitant per day. It would obviously be impossible to bring the per capita consumption to a very low figure in either of these towns by putting meters on all of the domestic services. In many places the rates charged large users of water are so low as to encourage the use by manufacturers of water from the public works rather than from private supplies, being in some cases less than the actual cost of supplying

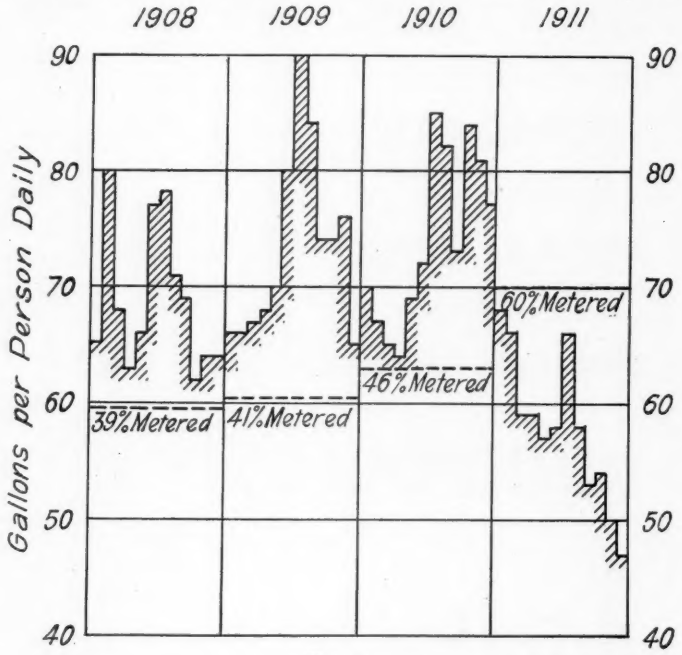


FIG. 1.

REDUCTION OF CONSUMPTION BY METERING A SINGLE SERVICE.

the water, and what is needed to reduce the consumption in such cases is not the introduction of domestic meters, but the introduction of more equitable water rates.

A better basis for comparing the domestic consumption would be to first deduct the quantity of water used for manufacturing and mechanical purposes. If this were done, it would be found that many of the great differences which appear in the per capita consumption would disappear. Thus, for example, if the consumption of water by the twenty largest consumers were deducted from the total consumption, it would leave in Brockton, where the reported consumption is 39 gal. per person per day, a domestic consumption of 35 gal. per person per day. In Taunton, where the reported consumption is 63 gal. per person per day, there would remain a domestic consumption of 47 gal. per person per day. The town of Peabody would have a domestic consumption of only 55 gal. per person per day instead of 152 gal. as reported. The domestic consumption, after deducting the manufacturing consumption, would be very much more nearly the same in the different places, and some of the places having low consumption, which now serve as examples of what meters will do, would change places with some of the other towns which report larger consumptions.

The quantity of water which is stolen from the pipes cannot be reduced by the introduction of domestic meters, and this item is of considerable importance, as I have had occasion to learn recently.

In a Massachusetts town having about one third of the services metered the consumption has been about 75 gal. per person per day for several years. (Fig. 1.) A little over a year ago the night consumption was so irregular that the engineer at the pumping station could detect it on his pressure gage indicating a heavy draft during certain hours. An investigation showed only one place where there could be any night draft sufficient to cause such irregularities and this was in a factory running all night and supplied with a large connection for fire protection. A meter was placed on this connection and the result was as shown on the diagram. The water had been stolen from the fire service at a rate of more than 200 000 gal. per day.

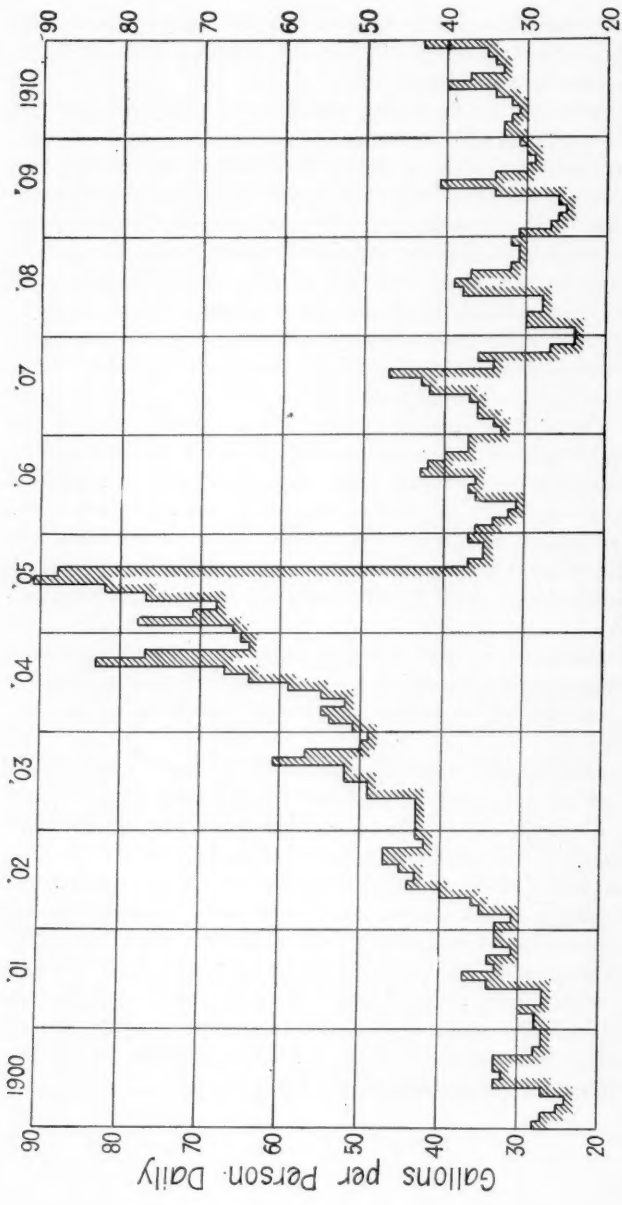


FIG. 2.
REDUCTION OF CONSUMPTION BY DISCOVERY OF A LEAK.

Not all of the gain shown on the diagram, however, can be attributed to this one cause. A considerable portion of the saving, especially during the latter part of the year, has been due to the placing of the new meters on services where it was expected they would do the most good instead of placing them only where requested by the consumer, as had been the custom previously. In most towns it is a fact that meters on a quarter of the services, if the services are intelligently selected, will accomplish three quarters of the saving of water which can be expected by metering every service.

Leakage from the mains and service pipes in the streets is another large source of loss of water which domestic meters do not affect. One of the best illustrations of this is shown in Fig. 2. In this town the consumption had been increasing at a rapid rate, and it seemed that an additional supply must be secured. In fact, investigations were already begun when some observant person noticed during the fall of 1905 that more water was coming out of one of the culverts than was entering at the other end, and it was discovered that there was a broken pipe which had been discharging into this culvert for an unknown period. In this town, undoubtedly, Fall River and Brockton were quoted, and it was maintained that the only proper solution of the water-supply problem was the introduction of meters, and yet by the discovery of a leak the consumption was reduced from 80 gal. to 35 gal. per person per day.

Another excellent illustration of what can be done without meters in reducing the consumption of water is found in Gardner, Mass. (Fig. 3.) The superintendent, Mr. Edwin L. Stone, a member of this Association, has given me permission to quote his statement as to the results accomplished.

"The superintendent having died in December, 1908, I was appointed superintendent by the Water Commissioners, March 1, 1909. As I was used to handling a plant which was 95 per cent. metered I naturally thought the consumption very large. It was the custom of the water department to make an inspection every two years and as this was the year for such an inspection a man was sent around to ascertain the number of fixtures and size of families and to find leaky fixtures. He was also armed with an aquaphone and instructed to listen for any unusual noise on the

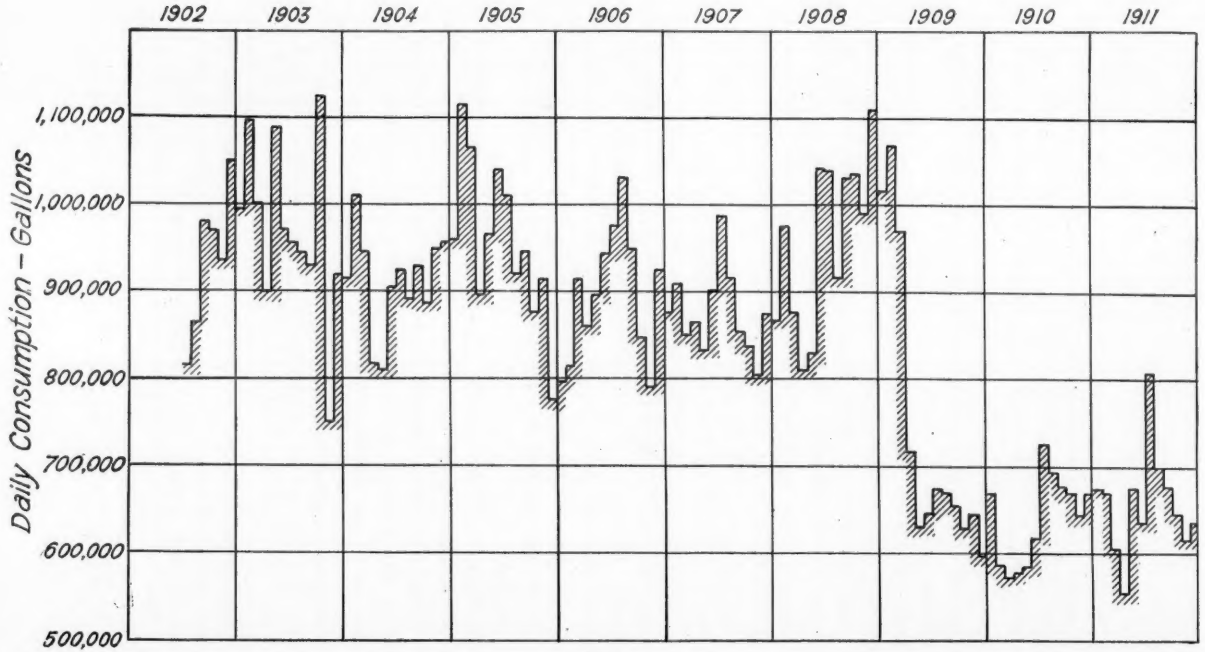


FIG. 3.

REDUCTION OF CONSUMPTION IN GARDNER, MASS., BY SYSTEM OF INSPECTION FOR LEAKS.

service pipes which might indicate leaks. Quite a few leaks were found in this way. Notice was at once sent from the office to have leaky fixtures repaired, and this was followed by another inspection of all leaky fixtures.

"As soon as the weather permitted I made a very careful inspection of all the hydrants and gates and in this way found many leaks in the main pipes and services, which, when fixed, made a big reduction in the water consumption. The result in the first year, nine months of which were under the new conditions, was a saving of 358 000 gal. per day, or a per capita consumption of about 54 gal. The result can be shown better by comparing the years 1908 and 1910, which gives a full year under the old conditions and a full year after the inspection was made

Daily consumption 1908, 1 100 745 gal. or 71 gal. per capita.
" " 1910, 640 602 " or 43 " " "

Saving, 460 143 gal. per day, or about 42 per cent.

"The leaks that were found and repaired were as follows:

100 to 150 leaky fixtures.
86 outside leaks.
43 joints.
8 pitted wrought-iron pipes.
3 gates.
2 breaks.
12 hydrants.
2 curb cocks.
8 lead connections.
1 $\frac{3}{4}$-in. pipe broken.
6 leaks were found on private fire services.

"I find it quite a problem after reducing the consumption to keep it within bounds. This I do by making a careful study of the consumption at all times, recording each day's consumption on a chart, noting the consumption particularly between 6 P.M. and 6 A.M. I will say, without the aquaphone and a Winslow recording instrument you are lacking the most valuable assistance. Too much value cannot be placed upon the aquaphone when in experienced hands.

"The water saving amounted to 168 000 000 gal. per year. There is no way of placing a value on this water, but taking the cost of our auxiliary pumping at Perley Brook, which is $24.42 per million, this made a saving to the town of about $4 100.

"There was a saving in the coal pile at the pumping station of 245 tons, which at $5.10 amounted to $1 250, or a total saving of $5 350 per year.

"Considering that we have only 6 per cent. of our services metered and have a per capita consumption of only 43.5 gal., or 366 gal. per tap, I feel well pleased, and find it a well-paying proposition to keep constantly after the leaks."

The quantity of water used for public purposes is frequently a large percentage of the total supply, and domestic meters do not remedy this. A drinking fountain will consume an enormous quantity of water unless properly regulated. Flush tanks on sewers, which fortunately are not common in this vicinity, use enormous quantities of water. In one city in another state, which is entirely metered, and where the quantity passed through meters was considerably less than half of the quantity pumped, it was found upon investigation that almost as much water was being used in the automatic flush tanks at the dead ends of sewers as was being passed through domestic meters.

A very unusual opportunity to study the effect of meters in a

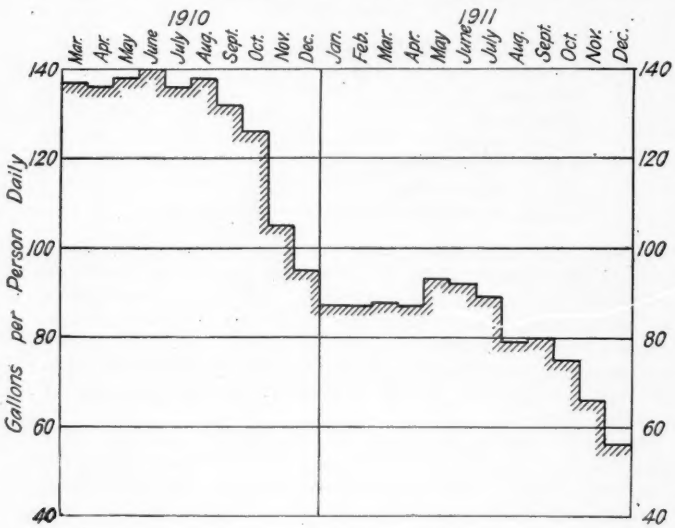


FIG. 4.

REDUCTION OF CONSUMPTION AT SOUTHBRIDGE WITH THE INSTALLATION OF A VENTURI METER.

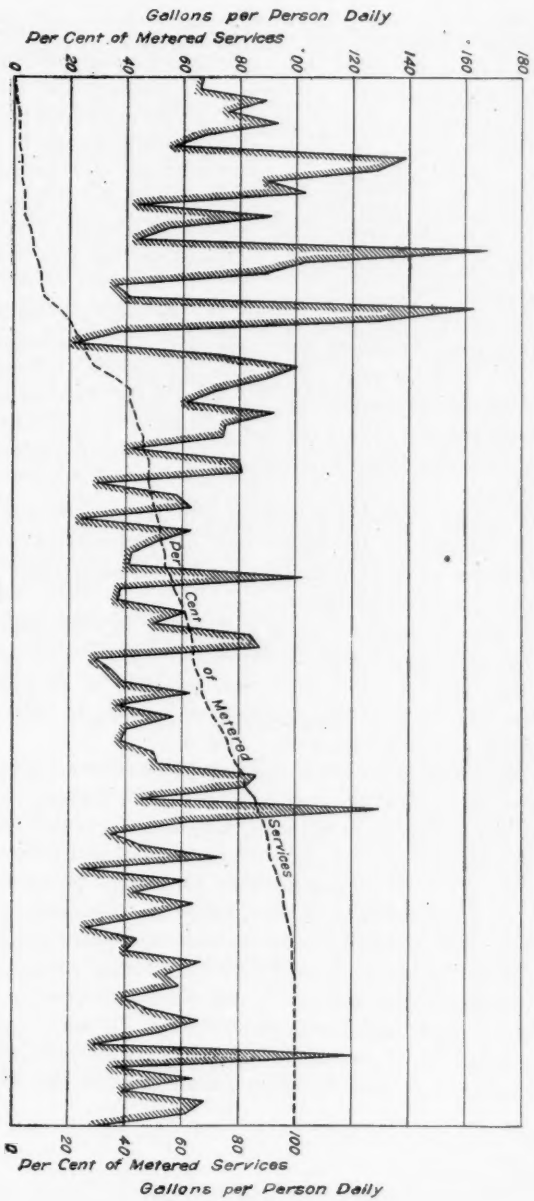

Gallons per Person Daily
Per Cent of Metered Services
0
20
40
60
80
100
120
140
160
180
Per Cent of Metered Services
0
20
40
60
80
100
Per Cent of Metered Services
Gallons per Person Daily

FIG. 5.

town previously entirely unmetered is found in Southbridge. (Fig. 4.) This town is supplied by gravity, and until early in 1910 there were practically no meters in operation and there was no means of measuring the total quantity used by the town. In May, 1910, a Venturi meter was put into operation, and it was found that the consumption was nearly 140 gal. per person per day. This led to an inspection, which revealed several large leaks, the most of which were in factory yards. As a result of the inspection alone, the consumption was reduced from 140 gal. to 90 gal. per person per day.

It was then decided to meter the services, and, as soon as the meters could be placed, every service in town was supplied with a meter. It is too early yet to ascertain the effect of this wholesale introduction of meters, but the consumption in December, 1911, was 56 gal. per person per day instead of 90 gal., which was the consumption after the inspection but before the introduction of meters.

The total reduction in consumption has amounted to more than 1 000 000 gal. per day, 60 per cent. of which was due to inspection stimulated by the introduction of a Venturi meter, and 40 per cent. was due to domestic meters.

For the purpose of showing in a general way the relation between the percentage of metered services and the per capita consumption I have plotted the consumption for 1910 in all Massachusetts cities and towns having consumption records, in order of the percentage of services metered. (Fig. 5.)

The places on the left of the diagram have very few meters, while those on the right are thoroughly metered. As would be expected, the high points occur generally among the places having few meters and those on the right among the metered towns can be accounted for. For example, the two highest points on the right of the diagram represent Manchester and Dedham, where a high consumption would be expected whether metered or unmetered.

Excluding the abnormal points the average consumption in the unmetered places is about 75 gal. per person per day, and in the metered cities and towns about 50 gal. It will be noticed that the reduction in consumption is much more rapid with the first 50 per cent. of services metered than with the last 50 per cent.

When we see side by side figures showing the total quantity of water used and the quantity passed through meters in those places where practically all of the services are metered, and find that generally only 60 per cent. and sometimes as little as 30 per cent. of the water is accounted for, it is plain that there is something yet to be done which the meters have not accomplished.

The slip of the pumps, and under-registration of meters, may account for some of the discrepancy, but when allowance is made for all of this, there still remains a large quantity of water which cannot be accounted for. This is where the efforts of the officials in those places which are already metered should be directed, and I have no doubt that as much can be accomplished in reducing the consumption in some of the towns which are already metered as in some of the places which are unmetered.

It seems to me that the only way by which we can avoid deceiving ourselves and others in regard to what meters are accomplishing is to separate the consumption of water into different classes, as was urged by Mr. Cole in a paper presented to the Association in 1910,* determining the quantity used for manufacturing, mechanical, and other purposes, and the quantity used for strictly domestic purposes. Then, instead of feeling that we have done our whole duty by putting meters on all services, let us reduce the "per centage unaccounted for" as has been done in some of the cases cited.

DISCUSSION.

MR. DEXTER BRACKETT.† This is a subject with which I have dealt for many years, and in which I have taken great interest. I agree with the speaker that the use of water meters will not prevent entirely the waste of water, or even as much as has been in many cases claimed by the advocates of water meters. I do, however, thoroughly believe that water meters should be used in connection with all water supplies, and they should be installed with the construction of the works. And, further, it is very desirable in works of any considerable size that the whole district

*JOURNAL N. E. W. W. A., Vol. 24, p. 636 (appointment of committee), and Vol. 25, p. 66 (Mr. Cole's paper).

† Chief Engineer, Metropolitan Water Works, Mass.

may be divided into sections, so as to conveniently measure the quantity of water used on different portions of the works. In this way the quantities which are used and wasted, both by the individual takers and from street mains, can be determined.

The conditions in different places are, as the speaker has stated, often very different. The city of Melrose may be considered as affording a fairly good example of the results which may be accomplished by the use of meters. In that city the per capita consumption in 1907 was 118 gal., and by the introduction of meters, and without any special effort to find leaks in the street mains, the consumption was reduced to 64 gal. in 1910, a saving of 54 gal. per capita. There is still opportunity for a considerable saving from leaks from the mains.

The adjoining town of Stoneham has several times largely reduced its consumption by finding leaks in the street mains, and at one time made a saving of about 300 000 gal. I say at one time, because subsequently the leakage from the street mains has increased, and has again been reduced in the same way, showing that there is need of constant vigilance.

Regarding the use of Venturi meters, I believe them to be very efficient instruments for the measurement of water, and very useful in connection with the detection of leaks, as by their use it is very easy to judge as to whether more water is being used during the night than is due to the proper consumption.

We have never made any careful scientific tests to determine the accuracy of the Venturi meters. There are sixty or more in constant use, measuring all the water that is used by the several cities and towns in the Metropolitan District. The water which is drawn from the reservoirs through the aqueducts is measured by means of current meters. A second measurement is made of the water by the displacement of the pumps at the pumping stations, and a third measurement is made by the several Venturi meters through which the several cities and towns are supplied. There are differences, due to leaks from some portions of our supply mains, which are not metered, but the three measurements from month to month agree within two per cent. I do not think there has been any month when it has been more than that, although possibly it may have been up as high as three per cent. This is

not a strictly scientific method of testing the meters, but at the same time it is a practical test, and it shows that the meters are not far from correct, or, at any rate, if they are not correct, all the other measurements agree with them.

MR. ALLEN W. CUDDEBACK.* It seems to me the primary object of domestic meters, and of all meters, is not necessarily to reduce the consumption of water, but rather to properly distribute the cost of water where it belongs. If the consumption is large and the domestic meters do not account for their proper proportion of the water, it puts the operating department on guard, and starts search for waste. Another important point, which has been brought to my attention during the recent cold spell, is this: We supply three towns. Two of them are 50 per cent. metered and the other is 100 per cent. metered. The consumption in the towns 50 per cent. metered has increased 50 per cent. in the recent cold spell, while the consumption in the town 100 per cent. metered has not increased at all. In this climate this is an important consideration, for often in periods like this the capacity of any plant may be overtaxed, where meters are not installed.

MR. BRACKETT. I would like to ask the last speaker whether in the town where there was no increase in consumption the works had not been recently installed, that is, within the last ten years, or if the meters were not installed at the construction of the works.

MR. CUDDEBACK. The meters were not installed at the construction of the works, but were installed only a few years afterwards; and the plumbing in the towns only 50 per cent. metered is somewhat older than in the town 100 per cent. metered. That is, the town 100 per cent. metered is a newer town.

MR. BRACKETT. The results in the different cities and towns where we have made observations show that where meters have been applied to old plumbing, in Boston, for example, the householder will let the water run if the plumbing is liable to freeze, because it is cheaper to pay for the water than it is to pay for removing the plumbing. As an illustration of the effect of cold weather, the use of water in the Metropolitan District increased

*Engineer and Superintendent, Passaic Water Company, Paterson, N. J.

from 103 083 400 gal. in December, which was comparatively warm, to 136 631 000 in January, which was a cold month, an increase of 33 500 000 gal. per day.

MR. CUDDEBACK. What percentage is that?

MR. BRACKETT. Approximately 33 per cent.

MR. FRANK L. FULLER. Was that all due, Mr. Brackett, to allowing the water to run to prevent freezing?

MR. BRACKETT. I know of no reason why the consumption should have been any larger in January than in December other than the effect of cold weather.

MR. FULLER. Mr. President, during the last cold days I have allowed the water in my house to run a little at night. I have taken a reading in the morning and compared it with a reading during twenty-four hours when there was no water running to waste, and found a very slight increase. That may be due to the water not being registered, but whether it is or not it shows me that it is unnecessary to let a great deal of water run to prevent pipes freezing.

In regard to a simple method of finding leaks in the street mains, especially when works are new, I would like to say that after the pipes have been filled and the pressure put on to the system, a gage may be connected with a hydrant and then the section in which the hydrant is located shut off. When the last gate is shut, see whether the pressure is maintained, or whether it gradually falls off. If there is a leak of much consequence the pressure will reduce very quickly; if it is small, not so fast; if there is no leak at all it will be some time before there will be much decrease in the pressure. I suppose after the water has been let on to the houses, by keeping the faucets closed, the result would be the same. Certainly a leak of large or even of moderate size could be quickly detected. In a large city it would be a slow process, but in the ordinary town it would take only a short time to do it.

MR. GEORGE A. CARPENTER.* Mr. President, I have been impressed on several occasions with the effect of the different methods used in computing per capita consumption. I assume that the usual way is to take either the plunger displacement, which many of us have oftentimes found to be greatly in error, or the meter measurements from a large Venturi meter, and to divide

*City Engineer, Pawtucket, R. I.

these figures by the total population, thereby arriving at the per capita consumption.

Ten years ago, when investigating this subject, I was rather surprised to find how low were the figures of actual per capita consumption when arrived at by a different process. For example, studying a city in 1900, taking the census enumerators' returns by districts, the actual metered consumption of the several houses in these districts, and dividing this metered consumption by the actual population, I found a domestic consumption of 16.3 gal. per capita, leaving out the manufacturing consumption. Taking the manufacturing consumption into account, the per capita consumption became 41.8 gal. per day. Based on plunger displacement and the total population, the consumption figured 90 gal. per capita per day.

Ten years later, or in 1910, when making a second study of this same city, and following the same methods as before, the actual domestic consumption was found to be 19 gal. per capita per day, and including the water used for manufacturing purposes it became 58 gal. per capita per day. At the same time the total water consumption for the city, as measured by a Venturi meter and dividing by the population served, was 80 gal. per capita per day.

The above figures show how large a proportion of the figures reported as per capita consumption applies to that portion of the water which passes through drinking fountains, flush tanks, leakage from mains and services, or escapes in ways of which we have, at present, very little definite information.

PROCEEDINGS.

December Meeting.

Hotel Brunswick,
Boston, December 13, 1911.

The President, Mr. Allen Hazen, in the chair.
The following members and guests were present:

Honorary.

Mr. F. P. Stearns.—1.

Members.

S. A. Agnew, C. H. Baldwin, A. F. Ballou, L. M. Bancroft, T. H. Barnes, F. D. Berry, F. E. Bisbee, A. E. Blackmer, J. W. Blackmer, C. A. Bogardus, Dexter Brackett, E. C. Brooks, James Burnie, J. C. Chase, G. E. Crowell, A. W. Cuddeback, E. D. Eldredge, G. F. Evans, G. H. Finneran, F. F. Forbes, A. N. French, F. J. Gifford, A. S. Glover, Clarence Goldsmith, J. N. Goodell, F. W. Gow, F. H. Gunther, R. A. Hale, R. K. Hale, F. E. Hall, Allen Hazen, W. S. Johnson, E. W. Kent, Willard Kent, F. C. Kimball, G. A. King, Morris Knowles, N. A. McMillen, H. V. Macksey, A. E. Martin, F. E. Merrill, William Naylor, G. A. Nelson, F. L. Northrop, T. A. Peirce, H. E. Perry, J. L. Rice, L. C. Robinson, P. R. Sanders, H. W. Sanderson, A. L. Sawyer, C. W. Sherman, G. H. Snell, F. N. Speller, G. A. Stacy, T. V. Sullivan, H. A. Symonds, C. N. Taylor, L. A. Taylor, H. L. Thomas, R. J. Thomas, E. J. Titcomb, D. N. Tower, C. H. Tuttle, W. H. Vaughn, G. E. Winslow. — 66.

Associates.

Ashton Valve Company, by C. W. Houghton and H. W. Ashton; Builders Iron Foundry Company, by F. N. Connet and A. B. Coulters; Darling Pump and Manufacturing Company, Ltd., by H. H. Davis; George E. Gilchrist Company, by G. E. Gilchrist; Goulds Manufacturing Company, by R. E. Hall; *Engineering Record*, by I. S. Holbrook; Hersey Manufacturing Company, by A. S. Glover, H. D. Winton, and W. A. Hersey; Fred A. Houdlette & Son, Inc., by M. S. Kahurl; Lead Lined Iron Pipe Company, by T. E. Dwyer; Ludlow Valve Manufacturing Company, by H. F. Gould; Charles Millar & Son Co., by C. F. Glavin; Mueller Manufacturing Company, by G. A. Caldwell; National Meter Company, by C. H. Baldwin, J. G. Lufkin,

and H. L. Weston; Neptune Meter Company, by R. D. Wertz; Pittsburg Meter Company, by R. A. Lester; Platt Iron Works Company, by F. H. Hayes; Rensselaer Valve Company, by F. S. Bates and C. L. Brown; A. P. Smith Manufacturing Company, by F. L. Northrop; Thomson Meter Company, by E. W. Shedd; Walworth Manufacturing Company, by E. H. Rice; R. D. Wood & Co., by E. J. Lame; Henry E. Worthington, by Samuel Harrison. — 30.

GUESTS.

J. G. Hill and R. W. Van Tassell, water commissioners, Lowell, Mass.; George Smith and John G. Howland, Springfield, Mass.; S. W. Hildreth, water commissioner, and J. L. Hyde, town engineer, Westfield, Mass.; F. M. Griswold, National Fire Prevention Association, New York City; B. E. Warren, Nashua, N. H.; Harry Barker, *Engineering News*, New York City; E. J. Mishler and George Schuhmann, Reading, Pa.; George H. Perry, E. F. Hughes, and Prof. W. H. Walker, Boston, Mass.; A. W. Powers, Cohoes, N. Y. — 15.

The Secretary read applications for membership, duly approved, from:

Active: Charles H. Ross, superintendent Waterloo Water Company, Waterloo, N. Y.; Alfred H. Young, superintendent Jewett City Water Company, Jewett City, Conn.; W. E. Miller, C. E., Madison, Wis., engaged in railway, gas, and water engineering; John L. Hyde, Westfield, Mass., engaged in municipal engineering.

Associate: Eddy Valve Company, Waterford, N. Y., manufacturers of valves, hydrants, etc.

On motion of Mr. Sherman, the Secretary was directed to cast one ballot in favor of the applicants, and he having done so they were declared duly elected members of the Association.

Mr. William H. Walker, professor of chemical engineering, Massachusetts Institute of Technology, presented a paper entitled, "An Investigation of the Relative Life of Iron and Steel Pipe as Found in Actual Service." The discussion was opened by Mr. F. N. Speller, metallurgical engineer, Pittsburg, Pa., representing steel-pipe manufacturers, and he was followed by Mr. George Schuhmann, vice-president and general manager of the Reading Iron Company, representing the manufacturers of wrought-iron pipe, and by Mr. Kahurl, representing the new

product manufactured by the American Rolling Mills Company. The discussion was also participated in by Mr. Smith of Springfield, Mr. Dexter Brackett, Mr. Robert J. Thomas, Mr. Edwin C. Brooks, Mr. Richard A. Hale, Mr. William F. Sullivan, Mr. George A. Stacy, Mr. F. N. Connet, and Professor Walker; and Mr. Schuhmann and Mr. Speller closed the discussion.

Adjourned.

Annual Meeting.

Hotel Brunswick,
Boston, Mass., January 10, 1912.

The President, Mr. Allen Hazen, in the chair.

The following members and guests were present:

Members.

S. A. Agnew, M. N. Baker, C. H. Baldwin, L. M. Bancroft, Randolph Bainbridge, F. A. Barbour, H. K. Barrows, C. W. Batchelder, A. E. Blackmer, J. W. Blackmer, C. A. Bogardus, George Bowers, Dexter Brackett, James Burnie, G. A. Carpenter, C. E. Chandler, H. H. Chase, P. M. Churchill, R. C. P. Coggeshall, M. F. Collins, J. H. Cook, John Doyle, E. R. Dyer, J. L. Dower, E. D. Eldridge, B. R. Felton, G. H. Finneran, J. H. Flynn, F. L. Fuller, Clarence Goldsmith, F. J. Gifford, A. S. Glover, J. M. Goodell, F. H. Gunther, R. K. Hale, E. A. W. Hammatt, W. E. Hannan, A. R. Hathaway, T. G. Hazard, Jr., Allen Hazen, D. A. Heffernan, M. F. Hicks, H. K. Higgins, C. L. Howes, W. S. Johnson, A. W. Jepson, E. W. Kent, Willard Kent, F. C. Kimball, G. A. King, Morris Knowles, E. E. Lochridge, F. A. McInnes, S. H. McKenzie, W. A. McKenzie, N. A. McMillen, A. E. Martin, John Mayo, F. E. Merrill, Leonard Metcalf, H. A. Miller, E. L. Northrop, T. A. Peirce, W. J. Sando, C. M. Saville, J. Waldo Smith, Sidney Smith, G. H. Snell, G. A. Stacy, C. T. Treadway, W. F. Sullivan, J. A. Tilden, C. H. Tuttle, W. H. Vaughn, J. H. Walsh, L. R. Washburn, R. S. Weston. — 77.

Associates.

Anderson Coupling Company, by C. E. Pratt; Builders Iron Foundry, by F. N. Connet and A. B. Coulters; Chapman Valve Manufacturing Company, by Robert Shirley and H. L. DeWolfe; Goulds Manufacturing Company, by R. E. Hall; *Engineering Record*, by I. S. Holbrook; Darling Pump and Manufacturing Company (Ltd.), by J. L. Hough and H. H. Davis; F. H. Hayes Machinery Company, by F. H. Hayes; Hersey Manufacturing Company, by

Albert S. Glover, J. A. Tilden, and W. A. Hersey; Kennedy Valve Company, by F. C. Flinn; Lead Lined Iron Pipe Company, by T. E. Dwyer; Ludlow Valve Manufacturing Company, by H. F. Gould; Charles Millar & Son Company, by C. F. Glavin; H. Mueller Manufacturing Company, by G. A. Caldwell; National Meter Company, by C. H. Baldwin and J. G. Lufkin; Norwood Engineering Company, by H. M. Hosford and C. E. Childs; Rensselaer Manufacturing Company, by C. L. Brown and F. S. Bates; A. P. Smith Manufacturing Company, by F. L. Northrop; Union Water Meter Company, by Edwin P. King and E. K. Otis; United States Cast Iron Pipe and Foundry Company, by D. B. Stokes; Waldo Bros., by H. E. Browne; Water Works Equipment Company, by W. H. Van Winkle; R. D. Wood & Co., by C. R. Wood and W. M. Simmons. — 32.

GUESTS.

S. Pitcher, Worcester, Mass.; W. G. Newhall, Portland, Me.; I. W. Flower, Roe Stephens Manufacturing Company, Detroit, Mich.; H. M. Lofton, general manager Columbian Iron Works, Chattanooga, Tenn.; George E. Felber, Pittsburg Valve Company, Pittsburg, Pa.; W. L. Sharpe, chairman, and Albert S. Benson, chemist, East Greenwich, R. I.; Prof. Kendnon and A. J. Loepsinger, Providence, R. I.; Thomas T. O'Connell, water commissioner, Wakefield, Mass.; George W. Bowers, Lowell, Mass.; A. C. Dickerman, Edward C. Sherman, Frederick A. Cole, and Edward F. Hughes, Boston, Mass. — 15.

The President then introduced Mr. David I. Walsh who made a brief address to the Association.

The Secretary presented applications for active membership, properly endorsed and represented by the Executive Committee, from the following:

Lewis L. Wadsworth, Winchester, Mass., engaged in construction of fortifications, power houses, water and sewer works, for the Federal Government, and in building concrete bridges and in general work; Paul Hansen, University of Illinois, Urbana, Ill., engineering assistant, Massachusetts State Board of Health, chief engineer Ohio State Board of Health, state sanitary engineer of Kentucky, and at present engineer of the Illinois State Water Survey; Hervey A. Hanscom, West Medford, Mass., has been engaged in construction of Metropolitan Water Board's mains, Springfield steel main, Medway, Norton, and Barnstable complete water systems, and other New England plants; Herbert F. Salmonde, Westfield, Mass., has been engaged as chemist, Sanitary

District, Chicago, Ill., chemist Board of Health, Chicago, Ill., and at present chemist West Parish Filters (Springfield Water Works), Westfield, Mass.; Harington P. Stearns, Far Rockaway, N. Y., with the Queens County Water Company; Sam H. Pitcher, Worcester, Mass., assistant engineer city of Worcester.

On motion the Secretary was instructed to cast the ballot of the Association in favor of the applicants named, and he having done so they were declared duly elected members of the Association.

The Secretary read the following communication:

WATER DEPARTMENT,
BANGOR, ME., January 8, 1912.

MR. WILLARD KENT, *Secretary*
N. E. Water Works Association,
Tremont Temple, Boston, Mass.

Dear Sir, — I have been unable to secure any data from my own proceedings or from those of my father in regard to the effect of an alternating electric current on a pipe, from the standpoint of electrolysis. We have had the matter before us for some time, and have not come to any definite decision. Some state that they consider it as dangerous as the direct, and others claim it is harmless, and the greater number does not know.

Can you give me any information, or refer me to any one who can? Thanking you in advance for your kindness, I remain,

Yours very truly,

HAROLD H. SINCLAIR.

THE PRESIDENT. Is there any one who can inform Mr. Sinclair upon this important point? The alternating current is coming into fashion, and it is something we shall have to investigate.

The following reports of the officers of the Association were received:

REPORT OF THE SECRETARY.

Mr. President and Gentlemen of the New England Water Works Association, — Your Secretary submits the following report of the changes in the membership and general condition of the Association for the year ending December 31, 1911.

NEW ENGLAND WATER WORKS ASSOCIATION.

Year.	President.	Membership at End of Year.				Annual Convention.		Receipts.	Expenditures.	Cash Balance.
		Members.	Associate.	Honorary.	Total.	Place.	Date.			
1882	(Organized)	27	—	—	27	Boston, Mass.	June 21, '82			
1882–3	*James W. Lyon	37	6	—	43	Worcester, Mass.	June 21, '83	$245.00	$87.86	$157.14
1883–4	Frank E. Hall	48	9	—	57	Lowell, Mass.	June 19–20, '84	156.14	171.90	141.38
1884–5	*George A. Ellis	83	44	—	127	Springfield, Mass.	June 18–19, '85	651.84	511.44	281.78
1885–6	R. C. P. Coggeshall	106	47	—	153	New Bedford, Mass.	June 16–18, '86	1 658.50	1 643.42	296.86
1886–7	*Henry W. Rogers	137	52	2	191	Manchester, N. H.	June 15–17, '87	1 342.28	1 066.98	572.16
1887–8	*Edwin Darling	181	54	3	238	Providence, R. I.	June 13–15, '88	2 013.30	1 697.15	888.31
1888–9	*Hiram Nevons	209	64	4	277	Fall River, Mass.	June 12–14, '89	2 204.07	2 127.70	964.68
1889–90	Dexter Brackett	257	73	5	335	Portland, Me.	June 11–13, '90	2 511.27	2 346.65	1 129.30
1890–1	*Albert F. Noyes	281	74	5	360	Hartford, Conn.	June 10–12, '91	3 055.13	1 884.78	2 299.65
1891–2	Horace G. Holden	290	70	5	365	Holyoke, Mass.	June 8–10, '92	2 887.17	3 278.54	1 908.28
1892–3	*George F. Chace	338	69	5	412	Worcester, Mass.	June 14–16, '93	3 422.61	3 317.22	2 013.67
1893–4	*Geo. E. Batchelder	365	73	5	443	Boston, Mass.	June 14–16, '94	3 208.85	3 259.07	1 963.45
1894–5	George A. Stacy	401	81	5	487	Burlington, Vt.	Sept. 11–13, '95	3 147.41	3 115.99	2 673.03
1895–6	Desmond FitzGerald	442	82	5	529	Lynn, Mass.	June 10–12, '96	3 179.91	3 148.49	2 704.45
1896–7	*John C. Haskell	464	80	5	549	Newport, R. I.	Sept. 8–10, '97	3 340.23	3 322.94	2 721.74
1897–8	Willard Kent	488	77	5	570	Portsmouth, N. H.	Sept. 14–16, '98	3 002.13	2 786.95	2 936.92
1898–9	Fayette F. Forbes	494	73	5	572	Syracuse, N. Y.	Sept. 13–15, '99	2 825.71	3 050.23	2 712.40
1899–1900	Byron I. Cook	519	70	5	594	Rutland, Vt.	Sept. 19–20, '00	4 920.49	5 524.65	2 108.24
1901	Frank H. Crandall	493	58	4	555	Portland, Me.	Sept. 18–20, '01	4 238.55	4 283.22	2 063.57
1902	Frank E. Merrill	522	60	5	587	Boston, Mass.	Sept. 10–12, '02	5 158.48	4 680.32	2 541.73
1903	Charles K. Walker	520	55	3	586	Montreal, Canada	Sept. 9–11, '03	5 032.40	4 505.08	3 069.05
1904	Edwin C. Brooks	538	58	8	604	Holyoke, Mass.	Sept. 14–16, '04	5 328.31	5 528.21	2 869.15
1905	George Bowers	584	53	8	645	New York, N. Y.	Sept. 13–16, '05	5 431.16	5 411.58	2 888.73
1906	Wm. T. Sedgwick	618	51	15	684	White Mts., N. H.	Sept. 12–14, '06	5 366.94	4 845.14	3 410.53
1907	John C. Whitney	636	51	15	692	Springfield, Mass.	Sept. 11–13, '07	5 291.83	†4 222.06	4 480.30
1908	Alfred E. Martin	633	49	14	696	Atlantic City, N. J.	Sept. 23–25, '08	5 706.36	7 475.56	‡2 711.10
1909	Robert J. Thomas	647	55	13	715	New York, N. Y.	Sept. 8–10, '09	5 305.31	†4 566.84	‡3 449.57
1910	George A. King	678	56	13	747	Rochester, N. Y.	Sept. 21–23, '10	6 507.08	†7 237.60	‡2 719.05
1911	Allen Hazen	680	58	12	750	Gloucester, Mass.	Sept. 13–15, '11	6 440.90	†6 279.72	‡2 880.23

*Deceased. †Not including December JOURNAL and reprints. ‡Does not include $1 815 invested in bonds.

MEMBERSHIP.

The present membership of the Association is 750; that of one year ago was 747, a gain of 3 during the year.

The detailed statement of the changes in membership during the past year in the several grades is as follows.

MEMBERS.

January 1, 1911.	Honorary members	13			
	Deceased	1			12
January 1, 1911.	Total members		678		
	Withdrawals:				
	Resigned	18			
	Dropped	27			
	Died	9	54		
				624	
	Initiations:				
	January	2			
	February	5			
	March	9			
	April	7			
	June	7			
	September	10			
	November	2			
	December	4	46		
	One member elected in 1910, but qualified in 1911		1	47	
	Reinstated:				
	Members dropped in 1911		9	9	
					680
January 1, 1911.	Total associates		56		
	Withdrawals:				
	Resigned		2	54	
	Reinstated:				
	Associate resigned in 1909		1	1	
	Initiations:				
	September	2			
	December	1		3	
					58
January 1, 1912.	Total membership				750

The Secretary has received $6 249.71, which has been paid to the Treasurer, and has certified for payment bills amounting to $3 349.86.

A statement of the receipts, expenditures, accounts receivable and bills payable will be found in detail in the report of the Treasurer.

Respectfully submitted,

WILLARD KENT, *Secretary.*

The Treasurer, Mr. Lewis M. Bancroft, submitted the following report.

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and interest		$191.19
Initiation fees	$223.00	
Dues	2 871.00	
Total received from members		3 094.00
JOURNAL:		
Advertisements	$1 763.75	
Subscriptions	183.00	
Sale of JOURNALS	279.25	
Sale of Reprints	40.89	
Total received from JOURNAL		2 266.89
Miscellaneous receipts:		
Sale of "Pipe Specifications"	$61.80	
Dinners	821.00	
Sundries	6.02	
Total miscellaneous receipts		888.82
Total receipts		$6 440.90

Expenditures.

JOURNAL:		
Advertising agent, commission	$271.50	
Plates	146.17	
Printing	2 117.06	
Editor's salary	300.00	
Expense	52.19	
Amount carried forward	$2 886.92	

Amount brought forward		$2 886.92	
Reporting		58.25	
Reprints		222.25	
Envelopes		28.50	
Miscellaneous		13.00	
			$3 208.92
Office:			
Secretary, salary		$150.00	
Expense		46.27	
Assistant Secretary, salary		600.00	
Expense		139.26	
Rent		300.00	
Printing		12.50	
Membership list		186.25	
Stationery		84.86	
Envelopes and postage		134.60	
Library		6.25	
Miscellaneous		24.00	
			1 683.99
Meetings and Committees:			
Stereopticon		$68.66	
Dinners	$830.00		
Cigars	57.90		
Music	87.00		
		974.90	
Badges		55.50	
Circulars		153.50	
			1 252.56
Treasurer's salary and bond			67.50
"Pipe Specifications"			55.00
Miscellaneous expenses			11.75
Total expenses			$6 279.72

The Auditing Committee submitted the following report:

BOSTON, MASS., January 9, 1912.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers.

Respectfully submitted,

GEORGE H. FINNERAN,
ALBERT L. SAWYER,
JOHN H. WALSH,
Auditing Committee.

LEWIS M. BANCROFT, TREASURER,
In account with the New England Water Works Association.

RECEIPTS.			EXPENDITURES.		
1911.					
Jan. 1.	Cash on hand	$2 719.05	Bills paid		$6 279.72
	Received of Willard Kent, Sec'y	6 249.71			
	Interest on bonds and deposits	191.19	BALANCE ON HAND.		
			People's Savings Bank	$1 874.56	
			Mechanics Savings Bank	936.36	
			First National Bank	66.30	
			Liberty Trust Co.	3.01	2 880.23
		$9 159.95			$9 159.95

ASSETS AND LIABILITIES.

ASSETS.			LIABILITIES.		
Cash, balance in banks		$2 880.23	Accounts payable:		
Bonds Nos. 2642 and 2644, Lake Shore & Mich. So. R. R., 4%, due May 1, 1931. Book value, $1 815. Market value		1 865.00	Secretary's salary and expenses	$55.00	
			Secretary's incidentals	21.44	
Accounts receivable:			December JOURNAL and reprints	305.26	
Advertising	$598.75		Editor's salary and expenses	82.00	
Sale of JOURNALS	7.00		Reporting	81.50	
Reprints	14.00		Rent	100.00	
Specifications	.60	620.35			$645.20
			Surplus		4 720.38
		$5 365.58			$5 365.58

READING, MASS., January 9, 1912.

LEWIS M. BANCROFT, *Treasurer.*

The Editor, Mr. Richard K. Hale, submitted the following report:

Report of the Editor.

Boston, January 10, 1912.

To the New England Water Works Association, — I present the following report for the Journal of the New England Water Works Association for the year 1911.

The accompanying tabulated statements show in detail the amount of material in the Journal; the receipts and expenditures on account of the Journal for the past year (including the cost of the December Journal and reprints, bills for which were received too late to pay in 1911, and which are consequently not included in the Treasurer's statement); and a comparison with the conditions of preceding years.

Size of Volume. — The volume is somewhat smaller in total pages and pages of text than that of several preceding years.

Illustrations. — The total cost of illustrations for the year, including printing, has been $270.12, or 10.3 per cent. of the gross cost of the volume.

Reprints. — The usual fifty reprints of papers have been furnished to authors without charge, and additional reprints, when desired, at the cost of the paper and press work. The net cost to the Association for reprints has been $127.20. There have been no advance copies of papers prepared during the year.

Circulation. — The present circulation of the Journal is:

Members, all grades	750
Subscribers	61
Exchanges	29
Total	840

an increase of 13 over the preceding year. Journals have also been sent to 48 advertisers.

Advertisements. — There has been an average of 27 pages of paid advertising, with an income of $1 763.75, a slight increase over last year.

Pipe Specifications. — During the year the specifications for cast-iron pipe to the value of $61.80 have been sold. One thousand copies have been printed, at a cost of $55.00, representing a net gain of $6.80 for the year. The net gain up to a year ago had been $207.25, so that the total net gain from this source to date is $214.05. There are still about 582 copies of specifications on hand, or about $58.20 worth if sold at retail.

The Association has a credit of $4.61 at the Boston Post-Office, being the balance of the money deposited for payment of postage upon the Journal at pound rates.

There are no outstanding bills, on account of the JOURNAL, which are not included in these tables.

Respectfully submitted,

RICHARD K. HALE, *Editor.*

TABLE No. 1.

STATEMENT OF MATERIAL IN VOLUME XXV, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1911.

Number.	Date.	Pages of									Total Cuts.
		Papers.	Proceedings.	Total Text.	Membership Changes.	Index.	Advertisements.	Cover and Contents.	Inset Plates.	Total.	
1	March	144	45	189	—	—	32	4	9	234	26
2	June	87	7	94	—	—	32	4	5	135	5
3	September . . .	107	15	122	2	—	32	4	8	168	22
4	December . . .	65	5	70	1	6	32	4	4	117	4
	Total . . .	403	72	475	3	6	128	16	26	654	57

TABLE No. 2.

RECEIPTS AND EXPENDITURES ON ACCOUNT OF VOLUME XXV, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1911.

Receipts.		*Expenditures.*	
From advertisements . . .	$1 763.75	For printing JOURNAL . .	$1 440.31
From sale of JOURNAL . .	279.25	For printing illustrations .	97.75
From sale of reprints . . .	47.05	For preparing illustrations,	172.37
Subscriptions	183.00	For editor's salary	300.00
		For editor's incidentals . .	31.94
	$2 273.05	For advertising agent's commissions	269.50
Net cost of JOURNAL . . .	352.82	For reporting	139.75
		For reprints	174.25
	$2 625.87		$2 625.87

TABLE No. 3.

Comparison between Volumes XVII to XXV inclusive, Journal of the New England Water Works Association.

	Vol. XVII. 1903.	Vol. XVIII. 1904.	Vol. XIX. 1905.	Vol. XX. 1906.	Vol. XXI. 1907.	Vol. XXII. 1908.	Vol. XXIII. 1909.	Vol. XXIV. 1910.	Vol. XXV. 1911.
Average edition (copies printed)	1 200	900	900	900	1 085	1 000	1 000	1 150	1 000
Average membership	587	596	625	665	693	699	710	732	752
Circulation at end of year	656*	667	705	767	785	780	802	827	840
Pages of text	430	491	587	495	500	500	459	643	475
Pages of text per 1 000 members	733	824	939	745	722	715	646	880	632
Total pages, all kinds	619	794	784	662	669	681	627	808	654
Total pages per 1 000 members	1 051	1 332	1 254	995	964	976	884	1 090	870
Gross Cost:									
Total	$2 706.05	$2 928.77	$3 266.65	$2 573.61	$2 643.42	$2 733.61	$3 111.15	$3 490.81	$2 625.87
Per page	4.38	3.69	4.17	3.88	3.95	4.01	4.97	4.32	4.02
Per member	4.61	4.91	5.23	3.87	3.82	3.91	4.39	4.78	3.50
Per member per 1 000 pages	7.46	6.18	6.67	5.85	5.70	5.88	7.00	5.90	4.09
Per member per 1 000 pp. text	10.72	10.00	8.91	7.81	7.62	8.02	9.56	7.44	7.36
Net Cost:									
Total	$770.62	$648.11	$1 072.95	$387.96	$483.15	$131.06	$789.98	$1 334.06	$352.82
Per page	1.25	.82	1.37	.58	.72	.19	1.26	1.65	.54
Per member	1.31	1.09	1.72	.58	.70	.19	1.11	1.82	.47
Per member per 1 000 pages	2.12	1.30	2.20	.88	1.04	.28	1.78	2.25	.55
Per member per 1 000 pp. text	3.05	2.22	2.93	1.18	1.39	.39	2.43	2.83	.98

* Exclusive of three hundred sample copies.

On motion of Mr. Coggeshall it was voted that the reports of the Secretary, Treasurer, Auditing Committee, and Editor be received and placed on file.

The President then called for the report of the Committee "to look after and keep track of legislation and other matters pertaining to the Conservation, Development, and Utilization of the Natural Resources of the Country," Mr. M. N. Baker, chairman.

Report of Committee on Conservation, Development, and Utilization of Natural Resources.

Mr. M. N. Baker. *Mr. President and Members of the Association,* — The committee has no very specific report to make. In fact, its name has been sufficient to weight it down so that it has been unable to do anything for several years past. You are all quite as familiar as are the members of the committee with the conservation movement, and nothing has come up which it has seemed necessary for the committee to lay before you at this time.

The President. The next business is the report of the Committee "to prepare a Standard Specification for Fire Hydrants," Mr. H. O. Lacount, chairman.

Mr. George A. Stacy. Unfortunately, Mr. Chairman, Mr. Lacount is sick and unable to be present, but we expect a messenger from him with a document that we will desire to present, in addition to the report which has been submitted in print.

It is very unfortunate that just at the time when we have reached the climax of this long-drawn-out work the chairman cannot be here, for he has done a very large amount of the work.

The President. We will pass the consideration of the report of the Committee to Prepare a Standard Specification for Fire Hydrants, and I will call for the report of the Committee "on Uniformity of Hose and Gate Nuts and Direction of Opening," Mr. Frank L. Fuller, chairman.

Report of Committee on Uniformity of Hose and Gate Nuts and Direction of Opening.

Mr. Frank L. Fuller. Mr. President, Mr. Lacount called me up about an hour before I left for this meeting in regard to this matter, and I told him that it seemed to me that the work of the Committee on Uniformity of Hose and the Direction of Opening of Hydrants and Gates was covered by the report which the Committee on Standard Specification for Fire Hydrants had made, and I think that is true. It seems to me that the Committee on the Uniformity of Hose and Gate Nuts, etc., has really done its work and ought to be discharged from further service, for if there is anything further in this matter it will come up under the work of the new committee.

On motion it was voted that the report of the committee be accepted and the committee be discharged.

The President. The next matter is the report of the Committee "on Water Consumption and Statistics Relating Thereto," Mr. Leonard Metcalf, chairman.

Report of Committee on Water Consumption and Statistics Relating Thereto.

Mr. Leonard Metcalf. Mr. Chairman, I regret that your committee is not ready yet to make a report to you upon its work. We have gotten together quite a lot of material, but we regret to say that the material is not of the sort which we had hoped to get. I think all of you will appreciate the difficulties of the problem of getting records of this sort sufficiently comprehensive to be significant; and the committee — or at least I, for one — have come to the conclusion that we will be able to do more effective work — in fact, we think we can only present to you material of value — by taking the records of a certain number of plants, a few plants, and putting enough study on to those to get some fundamental facts.

Therefore, your committee asks that it may be continued another year, and takes this opportunity to ask that any of you

who may feel that you have within your company records, or the records of the plant which you are operating, material which could be worked up at an expense of time and money, perhaps, but material which is available, you would advise the committee of this fact, so that we may see if we cannot put the necessary work upon plants where we know the material is available.

I might say that in the course of a trip abroad this last summer I made a number of inquiries along this line to see if statistics had not been accumulated abroad with regard to the division or character of water consumption. In Germany in particular I found that records were available concerning the public uses of water, but there they virtually stopped. There was none of the division as between a domestic consumption and a manufacturing consumption which we are after, at least so far as I was able to find; and, of course, conditions of life and the use of water in this country are so different from the conditions abroad that we ought to study the problem at home. So your committee asks to be continued another year, Mr. Chairman, if that is the pleasure of the Association.

THE PRESIDENT. I am sure we all are glad to hear that this important matter is going forward. I think no action is necessary to grant the continuance for another year, as asked for.

Next is the report of the Committee "to collect Information as to Low-Water Yields of Catchment Areas in New England, and, at their Discretion, Outside of New England," Mr. Frederic P. Stearns, chairman.

MR. HAROLD A. BARROWS. Mr. Chairman, the chairman of the committee has asked me to read this very brief progress report of the work of the committee, dated January 10, 1912.

Mr. WILLARD KENT, *Secretary*,
New England Water Works Association,
715 Tremont Temple, Boston, Mass.

Dear Sir, — The Committee on Yield of Drainage Areas has no extended report to make at this time, but can report substantial progress in accordance with the plan described briefly in the report of the committee made to you at the annual convention in September. Circular letters and blank forms were submitted to all the members of the committee on October 25, with the ex-

pectation of including information upon the yield of drainage areas through the year 1911, which, owing to the conditions of drought prevailing well into the season, it was necessary to include in the period covered by our investigations.

Preparation of data by members of the committee and other parties is well under way, but a further period of several months will be required in which to complete this work.

Very truly yours,

FREDERIC P. STEARNS, *Chairman*,
H. K. BARROWS, *Secretary*,
For the Committee.

THE PRESIDENT. I think the work of this committee is one of the most important matters that the Association has in hand at this time, and while we want the result as promptly as possible, I think the necessary time to put the information in the best shape should be granted.

MR. J. WALDO SMITH then spoke of matters connected with the crossing of the Hudson River, giving incidents and figures concerning the investigation and progress of the work.

THE PRESIDENT. Is the Committee to Prepare a Standard Specification for Fire Hydrants now ready to report?

REPORT OF COMMITTEE TO PREPARE A STANDARD SPECIFICATION FOR FIRE HYDRANTS.

MR. GEORGE A. STACY. Mr. President, we have heard from Mr. Lacount. He has sent a preliminary statement to accompany the report made by the full committee, with a request that it be read. Mr. Sullivan, a member of the committee, will now read the statement, which is in the nature of an historical sketch introductory to the printed report which is before you.

MR. WILLIAM F. SULLIVAN. I regret Mr. Chairman, that Mr. Lacount is not here to-day, because of illness, to make this statement, but it has just been handed to me to read. It is as follows:

"Two years ago this committee made a progress report and submitted a tentative set of specifications for post hydrants. A year later we reported that unexpectedly we had been unable to carry out certain tests as planned on

present makes of hydrants, due to the fact that the manufacturers were unwilling to assist the committee by loaning sample hydrants for test, and it was recommended that the specifications previously reported be continued as the tentative specifications of the Association.

"Although we have not yet received any assistance from the manufacturers, we nevertheless have been able to obtain during the past year several hydrants for test, and from these tests, which have cost several hundred dollars to carry out, we have obtained some of the information desired. As a result of the further study of the subject, a few amendments of the specifications previously submitted have been found advisable, and we now present for your final consideration and adoption the specifications as amended, advance copies of which were sent to the members of the Association with the notice of this meeting. A copy of the specifications and notice of the meeting were also sent to each hydrant manufacturer of whom we had any knowledge.

"We wish to say also that these specifications have been sent to the hydrant committee of the N. F. P. A., and also American Water Works Association, and from the replies thus far received from the N. F. P. A. Committee and from previous interviews with chairman of the American Water Works Committee, it is believed that the specifications will meet the approval of both committees.

"We therefore trust that this Association will approve the specifications substantially as now submitted, to the end that there may be finally one standard hydrant specification for this country.

"H. O. LACOUNT, *Chairman.*"

PROPOSED SPECIFICATIONS FOR POST HYDRANTS. FINAL REPORT OF THE COMMITTEE.

1. SIZE.

a. The size of hydrants shall be designated by the nominal diameter of the net valve opening, which must be at least 5 inches for hydrants having two $2\frac{1}{2}$-inch hose connections and 6 inches for those having three or four $2\frac{1}{2}$-inch hose connections.

In hydrants having valve openings of shapes other than circular, the designation of size must be the diameter of the circle equal in area to that of the valve opening.

b. The net area of the waterway at the smallest part when the hydrant is wide open must not be less than that of the valve opening.

In new designs it is recommended that inside diameter of hy-

drants, especially at the outlets, be 7 inches and 8 inches respectively for hydrants having 5-inch and 6-inch valve openings.

c. Hydrants must be fitted with bell ends to fit New England Water Works Association standard pipe, or with flanges of standard dimensions and having standard bolt layouts, published jointly by the American Society of Mechanical Engineers and the National Association of Master Steam and Hot Water Fitters, as given in the following table. Holes are not to be drilled on the center line, but symmetrically each side of it.

Size of Pipe. Inches.	Diameter of Flange. Inches.	Diameter of Bolt Circle. Inches.	Number of Bolts.	Size of Bolts. Inches.	Flange Thickness at Edge. Inches.
2	6	$4\frac{3}{4}$	4	$\frac{5}{8}$ x 2	$\frac{5}{8}$
$2\frac{1}{2}$	7	$5\frac{1}{2}$	4	$\frac{5}{8}$ x $2\frac{1}{4}$	$\frac{11}{16}$
3	$7\frac{1}{2}$	6	4	$\frac{5}{8}$ x $2\frac{1}{2}$	$\frac{3}{4}$
$3\frac{1}{2}$	$8\frac{1}{2}$	7	4	$\frac{5}{8}$ x $2\frac{1}{2}$	$\frac{13}{16}$
4	9	$7\frac{1}{2}$	4	$\frac{3}{4}$ x $2\frac{3}{4}$	$\frac{15}{16}$
5	10	$8\frac{1}{2}$	8	$\frac{3}{4}$ x 3	$\frac{15}{16}$
6	11	$9\frac{1}{2}$	8	$\frac{3}{4}$ x 3	1
7	$12\frac{1}{2}$	$10\frac{3}{4}$	8	$\frac{3}{4}$ x $3\frac{1}{4}$	$1\frac{1}{16}$
8	$13\frac{1}{2}$	$11\frac{3}{4}$	8	$\frac{3}{4}$ x $3\frac{1}{2}$	$1\frac{1}{8}$
10	16	$14\frac{1}{4}$	12	$\frac{7}{8}$ x $3\frac{5}{8}$	$1\frac{3}{16}$
12	19	17	12	$\frac{7}{8}$ x $3\frac{3}{4}$	$1\frac{1}{4}$
14	21	$18\frac{3}{4}$	12	1 x $4\frac{1}{4}$	$1\frac{3}{8}$

Where working pressure is from 125 to 250 pounds, the standard for heavy flanges must be used.

2. GENERAL DESIGN.

a. Any changes in diameter of the water passage through the hydrant must have easy curves and all outlets must have rounded corners of good radius.

b. Hydrants must be so designed that with ordinary usage they will not cause water hammer.

c. Hydrants must be so designed that the leaded joint underground can be strapped.

In any new design it is recommended that the hydrant be so constructed that when the valve is shut it will remain tight when top of hydrant is removed or barrel is broken off.

3. MATERIAL OF BODY.

The hydrant body shall be made of cast iron of good quality, such as shall make the metal strong, tough, and of even grain. The strength of the cast iron must be that required by the specifications for standard cast-iron pipe 12 inches and less in diameter.

4. HOSE NIPPLES AND VALVES.

a. Hose nipples must be of bronze, threaded with a fine thread into the hydrant, and securely pinned in place.

b. Hose threads on all hydrants to be installed in any given community must of necessity be interchangeable with those already in service, but, where practicable, threads should conform to the 1906 National Standard adopted by the National Fire Protection Association. The essential features of the "National Standard" are a 60 degree V-thread, outside diameter on male threads of $3\frac{1}{16}$ inches and $7\frac{1}{2}$ threads per inch.

c. Inside hose-gate valves must have bronze working parts and be of rugged design and must not introduce an unnecessary friction loss. There must be ample clearance between the gate and the hydrant body when the gate is in any position. The gate and parts should be interchangeable and the valves should be located so as to be as accessible as possible for repairs. The gate must be designed so that it cannot come off in use. The top of the stem must be below the level of the hydrant stem nut so that the hydrant wrench can be freely operated. If outside hose-gate valves are used instead of inside valves, they must be of bronze or of iron with bronze trimmings, with lugs cast on the valve body, each valve must be bolted to the hydrant by two $\frac{3}{4}$-inch tap bolts, spaced $5\frac{5}{8}$ inches on centers. The valves must not project further than necessary and must be of the inside screw type, placed in a vertical position with the hand-wheel at least 3 inches below the base of the operating nut.

d. The stems of the hose valves must be not less than $\frac{3}{4}$ of an inch in diameter for the $2\frac{1}{2}$-inch valves, and not less than $\frac{7}{8}$ of an inch in diameter for the valves at the steamer connections.

e. The stem nut of the inside hose-gate valve must be $\frac{1}{2}$ of an inch square.

5. HYDRANT VALVE.

a. The seat must be made of bronze, securely fastened in place.

b. The valve must be faced with a yielding material such as rubber or leather except that if of the gate type a bronze ring may be used. The valve must be designed so that it can be easily removed for repairs without digging up the hydrant.

c. With gate type of valve, clearance of parts must be such that corrosion will not make the parts inoperative.

6. DRIP VALVE.

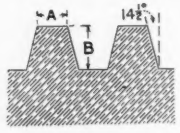
a. A positively operating non-corrodible drip valve must be provided and arranged so as to drain the hydrant when the main valve is shut.

b. The seat of the drip valve must be securely fastened in the hydrant. All other parts of the drip mechanism must be designed to be easily removed without digging up the hydrant.

7. OPERATING STEM.

a. The operating stem at the base of the thread where threaded, and also where it passes through the stuffing box and gland, must be of bronze not less than $1\frac{1}{4}$ inches in diameter. The bronze must have a tensile strength of not less than 32 000 pounds per square inch. The remainder of the stem may be of iron with cross-sectional area not less than $1\frac{1}{2}$ square inches, except at couplings, where the area may be 1 square inch. The operating stem must be attached so that in operation it will be impossible for it to become detached.

b. The stem must terminate at the top in a nut of pentagonal shape, finished with slight taper to $1\frac{1}{2}$ inches from point to flat, except for hydrants to be installed where existing hydrants have different shape or size of nut, in which case the additional hydrant must have the same operating nut as the old ones for uniformity. The nut socket in the wrench must be made without taper so as to be reversible.



$$A = \frac{0.3707}{\text{No. of threads per inch}}$$

$$B = \frac{1}{\text{Twice No. of thds. per inch}} + .01''$$

c. The thread which operates the valve must be Acme standard. See sketch opposite.

8. STUFFING BOX AND GLAND.

a. The stuffing box and gland must be of bronze or bronze-bushed. If a packing nut is used, it must be of bronze. The bottom of the box and end of the gland or packing nut must be slightly beveled.

b. Gland bolts or studs must be of bronze, iron, or steel, at least $\frac{5}{8}$ of an inch in diameter. The nuts must always be of bronze.

9. HYDRANT TOP.

a. The hydrant top must be designed so as to make the hydrant as weatherproof as possible and thus overcome the danger of freezing the stem. Provision must be made for oiling both for lubrication and to prevent corrosion. A reasonably tight fit should be made around stems.

b. There must be cast on the hydrant top, in characters raised $\frac{1}{8}$ of an inch, an arrow at least 4 inches long showing direction to open, and the word "Open" in letters 1 inch high.

10. HOSE CAPS.

a. Hose caps must be provided for all hose outlets, and must be securely chained to the barrel with a welded chain of wire not less than $\frac{1}{8}$ of an inch in diameter.

b. The hose-cap nut must be of the same size and shape as the stem nut.

c. A leather washer must be provided in the hose cap, set in a groove to prevent its falling out when the cap is removed.

11. MARKINGS.

Hydrants must be marked with the name or trade mark of the manufacturer, the nominal size, and the year of manufacture. All letters and figures must be cast on the hydrant well above the ground line. They must be 1 inch high and raised $\frac{1}{8}$ of an inch on the casting.

12. TESTING.

a. Hydrants must be tested to at least 300 pounds per square inch before leaving the factory. If the working pressure is over

150 pounds per square inch, the hydrants must be tested to twice the working pressure. The test should be made with the valve open in order to test the whole barrel for porosity and strength of hydrant body. A second test should be made with the valve shut in order to test the strength and tightness of the valve.

b. Hydrants must be fully opened and closed before shipping in order to test the freedom and strength of the parts. The conditions of the test should be made as severe as are liable to occur in service when using a hydrant wrench at least 17 inches long.

13. DIRECTION TO OPEN.

Hydrants must open to the left (counter-clockwise), except those to be installed where existing hydrants open to the right, in which case the additional hydrants must turn the same as the old ones for the sake of uniformity.

H. O. LACOUNT, *Chairman,*
GEORGE A. STACY,
FRANK A. McINNES,
FRED W. GOW,
WILLIAM F. SULLIVAN,
Committee.

THE PRESIDENT. Gentlemen, you have heard this report. Before taking action on this important matter I think full discussion of it should be had, and I think it only proper to say that the associate members having to do with hydrants are entitled to take part in the discussion. The matter is now before you, gentlemen.

MR. SAMUEL A. AGNEW. Mr. President, considering the fact that I have talked with some of the hydrant manufacturers and they have expressed a desire to be called in conference with this committee, before it was decided just what should be done with regard to changing hydrants and adopting a standard specification, I am rather surprised to hear that they have given no assistance whatever.

I do not know that it is in order, but if it is I would suggest that a committee be appointed to confer with the manufacturers, so

that the whole question may be threshed out with the men who certainly ought to know something about making hydrants.

As I understand, there are a good many minor changes suggested in this report, which would result in a considerable difference between the hydrants which are suggested and those that we are using at present. This will necessitate on the part of the water departments the keeping of duplicate sets of parts of different kinds of hydrants, which I should consider very undesirable. It is hard enough to take care of the hydrants we have and to keep on hand sufficient parts to keep the present hydrants in repair, without having to have a new set of hydrants and parts for them.

MR. SULLIVAN. Mr. President, I would say that this committee has already conferred with the manufacturers. We had one conference in Boston, and at that meeting the manufacturers said that they would continue to interest themselves in this matter, and that they would keep in touch with this committee. I do not know the reason why the manufacturers failed to coöperate and keep in touch with the hydrant committee. I know that Mr. Lacount, as the chairman of our committee, has given much time and thought to these specifications, and I know that on several occasions he gave the manufacturers an opportunity to come before the committee and discuss changes in the specifications.

As a member of the committee, I do not want to antagonize the manufacturers, and I think the committee as a whole is perfectly willing that the manufacturers even at this date should come in and confer with them. If another committee is appointed I do not see that there will be much need of the present one continuing along the lines upon which we have been working.

In order to bring the matter before the Association, which is the body to decide, and to bring it to your consideration so that you may act upon it, I move the adoption of these specifications as printed. I do not make this motion with the idea of rushing it through, but simply to give the members and the hydrant manufacturers who are here to-day in large numbers, an opportunity to express themselves and make known their objections.

I know the members of the committee are willing to meet the hydrant manufacturers on almost any ground. The committee's work has been simply to prepare a definite set of specifications,

so that the members of this Association, or any purchasers of hydrants, may know exactly what is a 5-in. hydrant or a 6-in. hydrant and the hydrant's characteristics and efficiency, its strength, durability, and method of manufacture on lines similar to the New England Water Works Standard Specifications for Cast-Iron Pipe. I hope that the members and the hydrant manufacturers here to-day will express themselves, so that by this means, at least, the hydrant committee will be able to get some information and learn what the manufacturers and members want regarding these specifications. The final word, however, with regard to hydrant specifications must come from the Association. You, gentlemen, are the final judges, for you buy and pay for the hydrants.

MR. FRANK C. KIMBALL. I second the motion that we adopt the specifications.

THE PRESIDENT. The matter is still open for discussion. I see several representatives of the manufacturers present, if I am not mistaken. Have they anything to say upon the subject? Are they satisfied with the specification, and if not, what changes do they desire?

MR. CHARLES R. WOOD. Mr. President, I have been asked by some of the manufacturers to speak for them on this subject. I will say that while we had some conferences with the committee we never had any particular standing as a body in any way. The manufacturers with whom I have discussed the matter seem to think that if the Association would appoint a committee, say, of five manufacturers who were interested in the manufacture of hydrants and associate members of the Association, to meet with Mr. Lacount, Mr. Sullivan, Mr. Stacy, and Mr. McInness, we might cut down the small differences which exist in the specifications as they are presented here to-day. These suggested specifications — I notice they are marked "Subject to revision" — differ greatly from the last set that were published, and, of course, the manufacturers have not had a chance — I think Mr. Sullivan will bear me out in this — to take up with the committee the changes which have been made. The manufacturers would like very much to have a committee appointed from the associate members who are interested in making hydrants, so they would have at

least some standing, perhaps with the addition of some officer of the Association, the President or some one, to make a little more formal matter of it, to take this matter up with your committee.

On the question of submitting hydrants for test, a number of us did agree to submit hydrants for test, and a number of us had them ready to send, with the idea that the test was for the purpose of showing the flow of water for the various sizes of valve openings. When we asked, however, what tests were going to be made, we were told that they would do whatever they wanted with the hydrants. I do not know whether that report came from the full committee, or whether it was a report to us individually, or whether every manufacturer was told the same thing; but we were told that our hydrants would be tested in any way the committee liked, whereas the original idea the manufacturers had was that they would be tested for the flow of water through the body of the hydrant.

We would be very glad to have representatives of the manufacturers, say five, the same number as the present committee of the Association, or whatever number you may think proper, take the matter up in detail, because there are but a very few things with which the manufacturers are not entirely satisfied in the specifications as they read to-day.

THE PRESIDENT. Is there any other statement to be made by any of the manufacturers?

MR. WOOD. Mr. Chairman, I was asked to speak for most of the manufacturers present. It did not seem necessary for all of us to talk along the same lines, but there are a number of manufacturers here, if the Association wants to hear from them.

THE PRESIDENT. The matter seems to stand in this way: We have a specification which has been prepared by a most competent committee, which, I take it, meets for the most part the approval of the manufacturers, but the manufacturers want some changes made in it. I have no idea what the character of those changes may be, but it seems that it would be well, perhaps, to defer action until a conference could be had along those lines. What do you say, Mr. Sullivan?

MR. SULLIVAN. Mr. President, in regard to the revision of

these specifications from the previous draft, I would say that most of the revision was done from suggestions made by the manufacturers. Now, I presume that in the main these specifications are satisfactory to all parties; and I would offer a suggestion, although I have made a motion and it may not be in order at this time, that these specifications be gone over rapidly by sections or by items, so that we may find out what items do not accord with the ideas and practice of the hydrant manufacturers. Of course the Association has the authority to appoint an additional committee to meet with the present hydrant committee, and I do not think any member of the hydrant committee will object to that. It seems to me, however, as this thing has been hanging fire for several years, we might be able to clear it up more quickly by having the hydrant manufacturers who are here express their views now. I earnestly suggest that this matter be taken up, and that the hydrant manufacturers point out what items or what sections in the specifications they object to.

MR. WOOD. Mr. President, we have had these specifications in our hands only four or five days, and we have not had time yet to discuss the matter thoroughly among ourselves. We would like, rather than to go into detail as to requests for changes in the specifications at present, to have a chance to confer among ourselves, and then to confer with the committee. There may be some suggestions which it will not be necessary for us to make, when we know all the reasons which the committee have for suggesting certain paragraphs in the specifications.

THE PRESIDENT. It seems to the Chair that there is no occasion for a change in the committee; that our present committee can handle this matter as well as any that can be appointed; and it seems to the Chair, further, that the manufacturers are well organized and well represented, and that they can present the matters that they have in mind to the committee, and that the committee can consider them and report back to the Association at a very early date. It would seem to the Chair that this would be the wisest solution of the problem. There is a motion before you, gentlemen, to the effect that these specifications be adopted. Is there any further discussion?

MR. FRANK L. FULLER. Mr. President, I would like to ask the

committee in regard to a point which, perhaps, is one of minor importance, but on page 80, in speaking of the operating stem, it says it shall be "finished with slight taper." Then, further on, it says: "The nut socket in the wrench must be made without taper so as to be reversible." I think the fire underwriters prescribe that the operating stem shall be without taper, and also that the nut on the wrench shall be without taper. It seems to me that if there is a taper on the stem there should be one in the wrench, and I would like to ask the committee what the object is in having the wrench without taper and the stem with taper.

MR. GEORGE A. STACY. A hydrant wrench is liable to be used either side up, and I do not see how you could have a taper in your wrench unless you had it marked and could be sure that the firemen were going to have it that side up all the time. The taper on the nut makes it a little easier to fit the wrench on, as a man rushes to a hydrant to open it, in the excitement of a fire. It is not correct mechanically, perhaps, but it is practically. If the hydrant nut fitted the wrench the whole way, it would be difficult to get the wrench on under the conditions that exist at a fire. Another factor which enters into the problem is the small boy with a stone for a hammer. If the wrench fits tight all the way down on the nut, it takes but a few minutes for a small boy to fix the nut so that you cannot get the wrench on, without some trouble. They do that sometimes in the best communities. Now, if you have got a little taper on the nut, and you have got a little leeway in putting your wrench on, a man will fit it more quickly, and you will get sufficient bearing on the base, where it will fit closely, so that you will have sufficient bearing to operate it without any trouble.

MR. M. N. BAKER. If it is in order, Mr. President, I would like to offer a substitute for the motion before the Association, to this effect: That the associate members interested in the manufacture of hydrants be requested to confer with this committee on the subject, and that the committee report to the Association at a later date.

It seems to me that will perhaps clear the ground. I offer it merely as a suggestion to aid in getting the matter straightened out.

THE PRESIDENT. Mr. Sullivan's motion is for the immediate adoption of the specifications as they stand. Mr. Baker's substitute is to request the associate members to confer with the committee, and to request the committee to report again to the Association.

MR. SULLIVAN. Mr. President, I am willing to withdraw my motion for the adoption of the specifications. I made the motion so as to get the specifications discussed. With the permission of the gentleman who seconded my motion, and if there is unanimous consent, I withdraw my motion for adoption.

We have with us to-day Mr. Teague, who is an assistant to Mr. Lacount, our chairman; he can give you some data regarding the hydrant tests. He is not a member of the Association, and I respectfully ask that the privileges of the floor be extended to him to speak regarding the hydrant tests while the members are here, so they can better know what the committee's ideas were in making these tests.

THE PRESIDENT. Do you suggest that he speak to us before the disposition of the matter which is now pending, Mr. Sullivan?

MR. SULLIVAN. I withdraw my motion.

MR. KIMBALL. I will withdraw my second.

MR. WALDO SMITH. I thoroughly agree, Mr. President, that the consideration of this matter should be postponed. I know that there are a great many engineers and water-works superintendents here to-day who feel that there has not been sufficient time since this report has been out to consider it. The first of the year is a very busy time, and a great many of us have not had time to consider this report. I am in favor of Mr. Baker's motion, except I believe it would be wiser, instead of leaving it to the manufacturers to get together as a whole with this committee, to have the President of the Association appoint a committee of the manufacturers, not a large number, whose business it will be to learn the views of the rest of the manufacturers and confer with the committee. That is the only difference of opinion I have with Mr. Baker; but it seems to me that perhaps the matter can be handled better in that way than by leaving it to all the manufacturers.

THE PRESIDENT. What do you say on that point, Mr. Wood?

MR. WOOD. That was the original suggestion that we made, that the President of the Association appoint a committee of five, because there were five on the other committee, and that would seem to be a sufficient number to make up the committee. That would be very satisfactory to the manufacturers. The number of the committee might be left to the discretion of the President.

THE PRESIDENT. Of course under this arrangement those men would not be members of the committee. It would be their duty to present the manufacturers' side of the case to the committee.

MR. WOOD. Certainly.

MR. BAKER. I am perfectly agreeable to that, Mr. President, if that is the idea of the Association. It does not make any difference whatever to me how it is got at, as long as the end is achieved.

MR. STACY. Mr. President, I think I can say there is no objection on the part of the committee to this conference. From start to finish we have only been anxious to get the best there was to get, and we have felt that we needed all the knowledge that there was in the business. We certainly concede to the manufacturers that they know something about hydrants, and the conference we had was a valuable one, although we were considerably apart on some things. While this matter has been dragged along, I think it is the desire of the committee that when the work is completed it should stand on solid ground, and that, as far as it is possible for human minds to agree, we should all agree that these specifications are the best for all parties that can be drawn up with our present knowledge.

THE PRESIDENT. I take it that the manufacturers will be prepared to act promptly on this, Mr. Wood?

MR. WOOD. At the call of the chairman of the committee.

MR. M. S. KAHURL. Mr. President, I would like to ask a question. We are manufacturing hydrants, and how will those of us stand who are not appointed on the committee? Will we be entitled to the information that is to be given to and from the committee?

MR. WOOD. As far as the manufacturers are concerned, we shall be only too glad to get suggestions from any manufacturer

of any hydrant, and all the information that we would have would be given out, and presumably all the information which the committee received would be given out to any manufacturer who wanted to know about it.

THE PRESIDENT. It is the feeling of the Chair that the best results would be obtained by allowing every manufacturer to go to the committee with all the "kicks" he has to make, and allowing every member of the Association to go with his.

MR. BAKER. That was my idea in suggesting, as I did, that the associate members who were interested in the subject be asked to confer with the committee, so that they could all have a chance. If they want to organize a subcommittee to take up the active work, that is within their power.

THE PRESIDENT. The question, I believe, is on Mr. Baker's motion.

MR. M. F. COLLINS. Before that motion is put, Mr. President, Mr. Sullivan has suggested that there is a gentleman here who wants to give some statistics on hydrant tests. It will only take a few minutes, and I hope the gentleman will have a chance to tell the Association what he has to say with regard to that matter.

THE PRESIDENT. I was planning to give him the floor, Mr. Collins, directly after putting this motion.

(Mr. Baker's motion that the associate members interested in the manufacture of hydrants be requested to confer with the committee, and that the committee report to the Association at a later date, was adopted.)

W. O. TEAGUE, Esq. Mr. President, I think what I have to say will not be so much to the point now as it would have been previous to the adoption of the motion which has just been put.

I wanted to say a word about the purpose of the tests which were made. The first draft of the specifications that was gotten up met the approval generally of the manufacturers, except as regards the size of the valve opening in the hydrant. The committee, as you remember, specified a 5-in. opening, — in other words, an area corresponding to a 5-in. diameter circle, — for a two-way hydrant. The question was raised as to whether this was neces-

sary or not. In order to settle that, it was necessary to make tests. We endeavored to get hydrants for this purpose from the manufacturers, but were unable to do so. We then, as was stated by Mr. Lacount, got some representative hydrants, and made tests on them, with the result that we showed conclusively that for a two-outlet hydrant a 5-in. valve opening is advisable. It seemed to us that that settled the main objection which the manufacturers had to the specifications as written at that time.

In addition to the tests, we made slight revisions in the draft of the specifications, to cover as far as possible the points — or objections you might call them — raised by the various manufacturers, so as to cover their particular design of hydrant without necessitating changes. Of course that could not be carried to an extreme and have the specifications suit all the hydrants that are made to-day. The best that could be done was to have pretty general specifications, representing the best conservative practice of the day in hydrant construction. For that reason it seems to me that the specifications as now before you are in final form, and that there are no vital points which need further consideration.

As I understand it, the purpose of the hydrant committee was, first, to recommend a basis for the designation of the sizes of hydrants. This has been done. In addition, it was the purpose of the committee to prepare a standard for good design, good construction, good workmanship, durability of parts and serviceability of the hydrants. We feel that the specifications as now written cover all these points, and it does not seem that further discussion of the matter with the hydrant manufacturers is going to lead anywhere. It simply means a delay. This work has been carried on in conjunction with the work which the Factory Mutual Fire Insurance Companies are doing along a similar line in connection with mill yard fire hydrants, and in view of that the committee has had the benefit of all the knowledge and data which the Mutual Companies have on the subject.

The thought in outlining these specifications was to have the hydrant in the street the same, or as nearly as possible the same, as that in the mill yard. We found finally that the only real difference that was necessary was in regard to the independent gate. The hydrant in the street should, of course, have inside gates,

since the outside hose gates form an obstruction and are apt to be broken off, whereas for mill yard use the outside gates are preferable. That feature is covered in the specifications as presented here.

In connection with the tests which were made for friction loss in hydrants we had intended to include in the specification a reference to the results; and in order that this may be made a matter of record I would like to read an abstract from Mr. Lacount's letter to the members of the committee, or, rather, the committees of the several associations, — that is, the New England Water Works Association, the American Water Works Association, and the National Fire Protection Association.

"It is proposed that the following be inserted in Article 2 on page 78: '*b*. With the hydrant discharging 250 gallons per minute through each $2\frac{1}{2}$-in. hose outlet, the total friction loss of the hydrant shall not exceed two pounds for two-way, three pounds for three-way, and four pounds for four-way hydrants.'"

This will of course advance the lettering of articles *b* and *c* to *c* and *d* respectively. As regards the maximum allowable friction losses specified in this item, we wish to say that these are considered very liberal, in view of the results that were obtained in the tests; that is, that with very little change in the average hydrant as made to day, such as rounding outlets and having good surfaces, the average hydrant could come well within this requirement. We did not think it advisable to endeavor to cut this allowable loss down too fine because we did not know where to stop. It is possible that later on these figures can be revised to some extent, but for the present, in order to get some working arrangement, it is proposed that friction losses as specified be allowed.

I have nothing further to say on the matter except that Mr. Lacount and myself are very confident that the work has been carried to such a point that no material improvement of the specifications can be expected from a further discussion or consideration of the details with the manufacturers, and for this reason we hoped that the specifications would be adopted as presented.

MR. LEONARD METCALF. Mr. President, might I through you make one suggestion to the committee in regard to these specifications, which is suggested by a casual reading of them, and that is that they should be self-contained, so you will not have to refer to any other document to have your full specification. I notice that in paragraph 3 the second sentence reads: "The strength of the cast iron must be that required by the specifications for standard cast-iron pipe 12 in. and less in diameter." Wouldn't it be desirable to have this requirement embodied in these specifications, so that in reading the specifications you have the entire thing before you?

MR. SULLIVAN. Mr. President, I remember that point was discussed at one of our meetings, and it was thought that embodying the New England Water Works Specifications for Standard Cast-Iron Pipe would make these specifications rather long; but I think the suggestion of Mr. Metcalf is good, and I do not know but it is the best thing to do.

MR. CHARLES E. CHANDLER. Mr. President, may I make one suggestion, at the request of the chief of the Fire Department of Norwich, Conn.? Under "Hose Caps," paragraph *c*, it reads: "A leather washer must be provided in the hose cap, set in a groove to prevent its falling out when the cap is removed." Our chief, Mr. Stanton, is of the opinion, and I beg the privilege of suggesting here, simply for the consideration of the committee in their further work, that a babbitt-metal washer that will not dry up and fall out, as leather washers do, might be an improvement over the leather washer. He has had a sketch made according to this idea, which I would be glad to have any of the members, and especially the manufacturers, look at, and if they should find any great difficulties in relation to the matter, of course they would not need to consider it further. But if it should prove, as Mr. Stanton thinks, that the babbitt-metal washer would be more effective and no more expensive, the object of this suggestion would be accomplished.

MR. SULLIVAN. Mr. President, that matter was taken up while we were having a conference with the hydrant manufacturers. I know it was discussed *pro* and *con* very thoroughly. The object of the leather washer was that when there were several

outlets to a hydrant, and only one line of hose attached, and no independent gate-valves, the water would be kept from spurting from the unused outlets and wetting the hydrant man who was operating the hydrant. But that is only a small detail, and I know the committee will be willing to consider it, although the leather washer was the outcome of the joint conference between the committee and the manufacturers.

MR. A. E. MARTIN. With regard to the leather-washer business, a year ago in Springfield we changed all our hydrant screw threads so that there should be no washers at all. We now use them plain without a washer, and we have no trouble in keeping the water from running out of the nozzles. They never leak at all; they are made very tight and metal faced.

MR. CHANDLER. May I ask if there is any corrosion of the metal and sticking of the cap at times?

MR. MARTIN. We never have had a particle of trouble so far. Of course we have only been using them a year, but before I went to Springfield I used hydrants in the same way for eighteen years, and I never had any trouble with them.

THE PRESIDENT. This is a most interesting and profitable discussion, and it is to be hoped that it may be continued when the specifications are reported back, and when certainly it is to be hoped they may be finally adopted and the business thus be standardized, as other branches of our work have been standardized.

PRESIDENT'S ADDRESS.

Gentlemen of the New England Water Works Association:

The past year has been, in most respects, one of quiet work and with no unusual events. In membership, there has been but a slight gain, the new members elected only slightly exceeding in number those lost through various causes. Financially, the Association has held its own, and the treasury is believed to be in satisfactory condition. These matters are set forth in the reports of the Secretary, Treasurer, and Editor, — which you have ust heard, — and do not need to be now repeated.

The deaths of ten of our members have been reported since the last annual meeting, namely:

		Elected to Membership.
John T. Fanning,	Civil Engineer, Minneapolis,	1885
Amos A. Gould,	Water Commissioner, Leicester, Mass.,	1896
C. A. Hague,	Civil Engineer, New York City,	1904
L. E. Hawes,	Civil Engineer, Boston, Mass.,	1888
L. P. Kinnicutt,	Chemist, Worcester, Mass.,	1893
A. R. McCallum,	Superintendent Water Works, Whitman, Mass.,	1906
C. W. Paine,	Civil Engineer, Highland, Cal.,	1888
W. H. Sears,	Civil Engineer, Plymouth, Mass.,	1899
Wm. H. Thomas,	Superintendent Water Works, Hingham, Mass.,	1887
W. P. Whittemore,	Chief Engineer Water Department, Attleboro, Mass.,	1886

From a physical standpoint, the year has been an interesting one, as the third in a cycle of dry years. The first part of the year was particularly dry, and, following two dry years, the deficiency in rainfall brought about conditions that were serious in many water-supply systems, especially where the catchment areas were small for the reservoir capacities.

This dry period, which now fortunately seems to have passed, has been one of the most notable that has occurred in New England since accurate records have been available.

One of the most important events of the year was appointing a committee by the Association to collect data as to this and other dry periods, and to study the whole subject. This committee is not yet ready to report, but it is believed that information will be obtained which will serve for many years as a basis for estimating the capacity of water supplies in New England.

It is nearly thirty years since there has been a record-making drought, and in this interval the records of the Sudbury River and a few other streams in the years following 1880 have been used as a basis for nearly all such calculations.

There is some reason for believing that earlier in the nineteenth century there was a drier period than that of the eighties, but records are inadequate.

When this report is available, it may be appropriate for the Association to discuss the question as to how far a practical rating of water sources should be based upon the records of the driest

year on record. Dry years may be classified according to the frequency with which they recur. There is a degree of dryness that is reached on an average once in ten years, and another reached on an average once in thirty years, the latter represented approximately by the dry period of the early eighties, and again by the dry period of the last few years. Presumably, there will be still drier years, which may be referred to in a general way as occurring not oftener than once in a century.

On the other hand, a water-supply system is seldom drawn to its ultimate capacity, and in fact can be but seldom so drawn with safety, because the consumption is always fluctuating, and enough water must be on hand to cover fluctuations and reasonable increases in rate, and in order to do this there is ordinarily some surplus capacity.

It may be questioned if it is justifiable as a practical business proposition to rate supplies on the droughts that only occur once in a century, or even on those which occur only once in thirty years, and whether it would not be better to take some less extreme basis, which basis could be established by proper records, and the limitations of which should be frankly recognized by writing them into all descriptions, and into the headings of tables.

For a city to be out of water is serious business. To be a little short one year in thirty may not be an intolerable condition, and it may be better business to have this happen than to build a whole water-works system so large that its capacity may only be needed once in thirty years.

Let us say, for example, that we will take some shorter period as a basis, such as ten years, and calculate the amount of water which can be certainly supplied nine years out of ten, and on an average in the tenth year, and take our chance on being a little short once in twenty or thirty years, if it so happens that the full rated capacity would be then used if it were available.

Following out this idea and developing it somewhat, it might be stated that a certain water supply was good for so many gallons per day four years out of five, for so many nine years out of ten, and for so many twenty-nine years out of thirty. Each figure for capacity in this series would be somewhat smaller than the preceding one, and the ratios between them could be fixed with

a fair degree of accuracy. We should then have a better idea of what chances we were taking, and what rating it was wisest to adopt.

It is the custom for the President to speak to you at the annual meeting upon some serious matter. Last year, our President gave us a most interesting survey of the whole field of water-works business throughout the civilized world. To-day, I choose a narrower subject, namely, the management of water works. I shall refer particularly to water works under municipal ownership, and I wish to consider the matter along somewhat broad lines.

The ownership and operation of water works by cities is a kind of municipal trading. That is to say, it has nothing to do with government, but is, on the other hand, engaging in private business by a public body, which business might otherwise be performed by private parties.

A public enterprise of this kind is always something of an experiment. There are cases where notable success has been achieved. We all agree that our Post-Office Department is, on the whole, well managed and gives better service than could be anticipated from private ownership. In European countries, the telegraph is managed by Government, and the service is generally cheaper than it is with us; but on the other hand, there are rumors of deficits in the Government telegraph accounts, and, so far as they occur, the taxpayers are making up for the lower charges on the messages. It is claimed that the privately owned telephone system in America is more efficient than any publicly owned system in the world.

We have not yet taken up government ownership of railroads (except in the unusual case of the Panama Railroad), but much has been done in this direction in Germany and other European countries, and in other parts of the world, including Canada and Mexico. Some excellent results have been achieved, but I think that most of us hold to the belief that company management of railroads is more appropriate and, on the whole, more efficient than government ownership.

In Europe, gas works and electric-light plants are frequently owned by municipalities, and in a few cases American cities have taken up these lines of trading.

In the beginnings of the water-works business in America, private companies played a large part, and many important works are still owned by companies; but as time has gone on, more and more undertakings have passed into public ownership, until a great majority of water-works plants are now owned by municipalities. In general, the management of publicly owned water works has been good, and has produced results satisfactory to the water takers, and not burdensome to the taxpayers. No doubt mistakes are made in municipally owned works, and some of these would be avoided by company management, but I doubt if the losses growing out of them would exceed those to be reasonably expected with private ownership of corresponding works.

Taking it right through, the public ownership of water works has been the most successful line of municipal trading thus far undertaken by American cities.

One fundamental reason for this is that the water-works business is naturally profitable. The income is easily and certainly collected, and is regular from year to year. Water can generally be secured and furnished at so small a cost that rates may be at once remunerative to the system and not burdensome to the takers. It has thus been possible in American cities to collect all necessary money to conduct the business, and it has rarely been necessary to burden the taxpayers in supporting these undertakings. These conditions have made it easy to operate plants without incurring deficits and with general satisfaction to the citizens, and have perhaps lead to easy-going ways in some matters, where better business methods might have been adopted.

I propose to talk to you to-day about this general subject, and see if we cannot do something toward getting better methods adopted by the works with which we have to do. I know that some of you have already done a great deal in this direction, and methods of management have been introduced which are admirable, as relating to particular parts of some systems.

There was presented to us two years ago* an excellent paper on depreciation as applied to the water-works business. Discussion brought out the fact that must have been known to nearly all of us, that systematic calculation and allowance of deprecia-

*JOURNAL N. E. W. W. A., Vol. 24, p. 305.

tion charges is rarely carried out in publicly owned works. It may be said, also, that privately owned water works have, as a rule, neglected to make systematic depreciation charges until during the last years, when the regulation of such corporations and decisions of the courts as to reasonableness of rates, have made them imperatively necessary. It is now recognized that in the financial management of a privately owned water plant, the annual depreciation must be carefully calculated and allowed each year, and there seems to be no reason why corresponding calculation and allowance should not be made for a plant that is owned by a municipality.

The reform in regard to depreciation charges is a most important one, but it is only one of a whole series that might be made with advantage.

Take the case of profits, or the return upon the invested capital, or, in the case of an old plant, on the fair value of the property. I think it is often true that the water-works management is satisfied if a balance is left in the hands of the treasurer at the end of the year, after operating expenses and the interest on the bonded debt have been paid, and perhaps some money put into extensions. But is this the whole question? Why should not a plant earn a fair return on its value, regardless of the amount of its indebtedness?

There are cases where the bonds originally issued to pay for water-works construction have been paid off, where additional construction has been paid for from earnings, and where the department is free from debt. There are other cases, fortunately less common, where bonds have not been paid off, where the works are depreciated, and where the plant is not worth the amount of the bonded indebtedness. Most plants lie between these extremes.

Let us consider for a moment the case of the plant that is out of debt. It is possible to operate the plant so as to pay its way, and to make water rates so low that they will cover only operating expenses and such other general expenses as have to be met, and water may be supplied at much less than cost.

Some people believe, no doubt, that this is the best way to manage the business, and that when works have once been paid for, the public may properly be given the benefit of this condition,

and supplied with water at whatever rates less than cost prove to be feasible.

I am disposed to take another view of the matter and to hold that no water-works system can be called really self-supporting that does not earn a reasonable return upon the whole value of the plant, regardless of its bonded indebtedness. Certainly, the rates that will suffice to make such return are as low as rates could be made if the business were now being taken up for the first time, and in case the rate of return or percentage on the capital is as low as is consistent with good municipal management, the rates reached under this condition may be taken as representing the real cost of the service.

If a city has, by good management, or in any way, acquired a property which is valuable, and is capable, at fair rates, of producing a net revenue representing a fair rate of return on its value, is it not the duty of the municipality to manage it as any other owner of a trading enterprise would do, to secure the fair return that naturally grows out of the business, and use that return for the benefit of the citizens in any way that is proper? This view largely prevails in American cities, although it is not frankly recognized. There are many cases where the water revenue is turned into the general funds and serves to diminish the amount of money raised by taxation. There are cases where bridges and other municipal structures having no relation whatever to water works have been built with water-works money.

What I suggest to you to-day is, that this matter of accounting, which in the past has been of a most haphazard character, should be reduced to a definite basis, and standardized in accordance with sound business principles, but without defining too closely the rates of return that are to be earned, which I think should properly be left to the good business judgment of those having to do with the matter from time to time.

Then there is the question of taxation and free water. Why should public trading be done on different principles from private trading? Why should a water works be exempt from taxation, and why should the water works furnish free water for hydrants, schoolhouses, churches, and all other public and quasi-public institutions? Probably the underlying idea in many cities has

been that the taxes that would otherwise be paid might be taken as an offset for the free water furnished to the city, and that the two things would balance each other, and that it would save bookkeeping to let matters go without calculation.

But this certainly is not a good business basis. Why should not the water-works plant be assessed taxes on its reasonable value, and why should not collection be made for all the water and services that are rendered?

The Interstate Commerce Commission has done away with dead-head transportation upon railroads. This action was a wise one, for the pass system had been atrociously abused. It meant a drain upon the railroads that could only mean higher fares for those who paid. But were the passes upon the railroads more abused than the free-water arrangement is abused in the case of municipally owned water works? If passes are abolished on the railroads, why should not dead-heads be abolished in the water business? Certainly, because a taker is another department of the city government, it is not sufficient reason why it should be supplied with free water.

On the railroads in the old days, it was, no doubt, true that those who had passes caused more trouble and expense than other travelers. So, I think, in your water departments, you will find that the dead-head takers are, in general, those who waste the most water, and that it costs the most to take care of. That which costs nothing is treated with but little respect. The school-houses that are furnished with free water will use gang closets or self-flushing closets to save a little money in plumbing, and the water will go pouring through them day and night, because the janitor has not sufficient interest to shut them off at night because it costs nothing.

Our water-works statistics relating to physical matters have been well standardized. Would it not be worth while to extend our form to include information as to the value of properties, the amount of depreciation allowed, taxes paid and free water furnished, the net earnings, and the per cent. which these are of the values? To find out the facts is the first step. The laws and ordinances that will provide for bettering the conditions may be logically expected to follow.

One reform that might naturally grow out of consideration of the business along these lines would be better and more uniform schedules of water rates. I do not believe that there is any other line of business that has such great and unreasonable variety in its schedule of charges as will be found in water works.

We have had committees on water rates, and a great deal has been done to straighten up and eliminate these eccentricities, but much remains to be done. The business cannot be considered to be in satisfactory shape in any given case until a serious effort has been made to find out what revenue is really required and to prepare a schedule of rates that will distribute that amount as fairly as it can be distributed, among all the different takers, keeping in mind reasonable limits of simplicity.

There are several different ways of approaching this subject that have merit. Following different ones in different cases results in rates that are not easily compared with each other. I suggest that it ought to be possible at this time to agree upon a general form of water rates that could be used in all cases, but with figures omitted, with the idea that they would be fixed in individual cases, to meet the requirements of the revenue to be produced, and the relative abundance or scarcity of water. Where water is relatively abundant, a larger part of the amount to be raised will naturally be placed upon the fixtures, and upon the privilege of having connection and having water available. Where water is relatively scarce, the amount to be raised will be proportioned in greater measure, or even altogether upon the quantity of water taken by the various consumers.

Such a uniform schedule might be similar in its general form to the schedules with which we are all familiar. Under fixture rates, there would be specified all the fixtures that would be charged for, and the method of rating them would be defined once for all, but leaving the amount of charge to be made for each item to be determined according to the requirements of particular cases. Under meter rates, the point would be settled whether the gallon or the cubic foot was to be the basis of the calculation, whether minimum rates were to be used, or whether, instead, a fixed charge should be made for the service, as recommended by our committee some years ago, with an additional charge for all

water used, and the question would be taken up as to whether the scale should slide, and if so, at what points, and those points would be fixed; but the rates for water, and for the minimum charges, or for service charges would be left to be fixed according to the requirements of each case.

Schedules made up in this way could be directly compared with each other, which is something that cannot be done with present schedules of water rates, except in rare cases, as all of us know who have had to do with the rates, when effort has been made to investigate them by judicial procedure.

I may mention another question in water-works management, that arises in the case of cities or towns lying close together, and supplied most conveniently from one system. Cases of this kind are always numerous, and are especially so in the more densely settled parts of the country, as in New England. There is the case of the suburbs of a larger town, and the case of several towns lying near together, where the most available source of supply is at some distance, and where a single system would best serve all. This is a phase of water-works business where municipal ownership, up to the present time, has been relatively weak. The company form of management has had a distinct advantage under these conditions, because it knew no city lines and could use one system, as far as it was physically advantageous to do so.

In Maine, water districts have been formed, the boundaries of which followed the limits of the territory that could be conviently supplied with one system of works, rather than political boundaries. This plan has also been used in other places in America, in Europe, and quite generally in Australia, and it has been, on the whole, one of the most successful means of dealing with this phase of the question.

The Metropolitan water district here in Boston is, perhaps, the most conspicuous case of a successful solution of this problem, but in this case the state took a hand, so that the works as they stand are quite as much a state affair as a municipal undertaking.

In other cases, especially in the case of suburbs, the works of a city have been extended in adjoining country, or water has been sold wholesale. In other words, the municipality has been given leave to extend its trading beyond its own boundaries. Arrange-

ments of this kind have been frequent, and are likely to be still more so, and in case one of the towns greatly predominates in size over the others, there is much to be said in favor of this arrangement. But there are many other cases where several municipalities have independent works, and are so situated that, physically, one system would better serve than several independent ones. The water problem may be the only one that draws these particular municipalities together, and coöperation between them in the line of economical development is often difficult or seemingly impossible. This is one of the most interesting problems to be solved in the question of municipal ownership.

Election of Officers.

The President. There remains only one item of business to complete the year's work, and that is the report of the tellers. Are the tellers ready to report?

Mr. Samuel A. Agnew. The tellers appointed to canvass ballots for the election of officers for the ensuing year submit the following report:

President.

George W. Batchelder	301

Vice-Presidents.

J. Waldo Smith	292
Frank A. McInness	302
Millard F. Hicks	298
John H. Cook	301
Morris Knowles	300
Robert S. Weston	301

Secretary.

Willard Kent	304

Treasurer.

Lewis M. Bancroft	304

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Richard K. Hale	303

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GEORGE A. KING 306

Additional Members of Executive Committee.

GEORGE A. STACY 301
JOHN J. KIRKPATRICK 301
RANDOLPH BAINBRIDGE 299

Finance Committee.

ALBERT L. SAWYER 301
FRED D. BERRY 299
JOHN W. MORGAN 301

The President thereupon declared the above-named gentlemen to have been elected officers of the Association for the ensuing year, and requested Mr. George A. King to escort the newly elected President to the chair. Addressing Mr. Batchelder, the retiring President said: I pass you, sir, the gavel, and congratulate you upon your election, wishing you and the Association all success during the year which begins with this act. [*Applause.*]

THE PRESIDENT. *Mr. Hazen and Gentlemen of the New England Water Works Association,* — I esteem it a great honor to have been elected as your President, and I shall make it my earnest effort during the coming year to advance your interests in every possible way in which I can. The success of any association depends very largely upon the coöperation in action of its members and its officers, and I sincerely trust that we shall all act together this year. I expect to receive the support and assistance of the other officers, of the committees, and of all the members, so that 1912 may be made a year of progress for the New England Water Works Association. I thank you, gentlemen. [*Applause.*]

Adjourned.

February Meeting.

Hotel Brunswick,
Boston, Mass., February 14, 1912.

George W. Batchelder, President, in the chair.
The following-named members and guests were present:

Honorary.

Frederic P. Stearns.

Members.

A. S. Agnew, C. H. Baldwin, G. W. Batchelder, J. W. Blackmer, George Bowers, Dexter Brackett, E. C. Brooks, I. W. Brooks, G. A. Carpenter, George Cassell, J. C. Chase, R. D. Chase, M. F. Collins, A. W. Cuddeback, A. O. Doane, E. D. Eldridge, G. F. Evans, C. R. Felton, F. F. Forbes, F. L. Fuller, F. J. Gifford, A. S. Glover, Clarence Goldsmith, J. M. Goodell, F. H. Gunther, R. A. Hale, R. K. Hale, F. E. Hall, J. O. Hall, T. G. Hazard, Jr., H. G. Holden, J. L. Hyde, W. S. Johnson, E. W. Kent, Willard Kent, G. A. King, J. H. McManus, N. A. McMillen, W. E. Maybury, John Mayo, H. A. Miller, F. L. Northrop, T. A. Peirce, Dwight Porter, P. R. Sanders, A. L. Sawyer, G. H. Snell, G. A. Stacy, T. V. Sullivan, W. F. Sullivan, H. L. Thomas, R. J. Thomas, L. D. Thorpe, J. L. Tighe, J. A. Tilden, E. J. Titcomb, C. H. Tuttle, W. H. Vaughn, L. J. Wilber, F. I. Winslow, G. E. Winslow, I. S. Wood. — 62.

Associates.

Anderson Coupling Company, by W. D. Cashin; Builders Iron Foundry, by F. N. Connet and C. J. Young; Chapman Valve Manufacturing Company, by J. T. Mulgrem; *Engineering Record*, by I. S. Holbrook; Darling Pump Manufacturing Company, by H. H. Davis; Goulds Manufacturing Company, by R. E. Hall; Hersey Manufacturing Company, by A. S. Glover, J. A. Tilden, and W. A. Hersey; Lead Lined Iron Pipe Company, by T. E. Dwyer; Ludlow Valve Manufacturing Company, by H. F. Gould; National Meter Company, by C. H. Baldwin, J. G. Lufkin, and H. L. Weston; Neptune Meter Company, by H. H. Kinsey and R. D. Wertz; Norwood Engineering Company, by C. E. Childs; Pittsburg Meter Company, by B. A. Lester; Platt Iron Works Company, by F. H. Hayes; Rensselaer Valve Company, by C. L. Brown; A. P. Smith Manufacturing Company, by F. L. Northrop and D. F. O'Brien; Thomson Meter Company, by E. M. Shedd; Union Water Meter Company, by F. E. Hall; Water Works Equipment Company, by W. H. Van Winkle, Jr., and E. S. Scott; R. D. Wood & Co., by C. R. Wood and H. M. Simons; Henry R. Worthington, by Samuel Harrison. — 30.

GUESTS.

John N. Brooks, Torrington, Conn.; J. J. Prindiville, water commissioner, Framingham, Mass.; Frank S. Hamlin, water commissioner, Haverhill, Mass.; A. E. Barrett, water commissioner, Lowell, Mass.; Daniel H. Gorman, commissioner, East Greenwich, R. I.; Henry F. Wilkins, John P. Goodwin, water commissioners, Marblehead, Mass.; Arthur W. Beckford, Henry Newhall, Danvers, Mass.; C. L. Leary, engineer public works, Peabody, Mass.; John J. Nugent, commissioner, Beverly, Mass.; Harry Greenhalgh, president Water Board, Fall River, Mass.; A. Allen, water commissioner, Westfield, Mass.; Raymond C. Allen, Manchester, Mass.; W. H. McGinty, Frank S. Bailey, and Tenny Morse, Boston, Mass.; Prof. H. C. Ives, Worcester, Mass.; and E. F. Hughes, water commissioner, Watertown, Mass. — 19.

The Secretary read the records of the last meeting. On motion of Mr. M. F. Collins the records as read were adopted.

The Secretary presented applications for membership, duly recommended and endorsed, from Henry Newhall, Danvers, Mass., superintendent; J. J. Prindiville, South Framingham, Mass., member and secretary Framingham Water Commissioners; Charles A. Leary, Peabody, Mass., in charge of Water, Street, and Sewer Division, Public Works; Charles William Saxe, Newport, R. I., chemist in charge of Filtration Plant, Newport Water Works; Earl W. Kelly, Duluth, Minn., engineer for Duluth Water and Light Department; Myron L. Fuller, Brockton, Mass., formerly chief of Eastern Section, Division of Hydrology, U. S. Geological Survey, and now consulting engineer on underground water supplies; L. E. Thayer, Waterville, Me., trustee Kennebec Water District and city treasurer; Samuel R. Hatch, Duluth, Minn., assistant to manager, Water and Light Department, Duluth; Marvin C. Birnie, Springfield, Mass., who has been engaged with the Thompsonville Water Company, Spafford Springs Aqueduct Company, and Stanton Aqueduct Company; Howard C. Ives, Worcester, Mass., assistant professor of railroad engineering, Worcester Polytechnic Institute. — 10.

On motion of Mr. T. A. Peirce, the Secretary was directed to cast one ballot in favor of the admission of the applicants, and he having done so they were declared duly elected members of the Association.

THE PRESIDENT. The members of the New England Water Works Association, I take it, are always glad to welcome anybody

who is entering their business. We have such a man with us today, the Commissioner of Water and Fire Protection, Lowell, Mass., and it gives me pleasure to introduce Mr. A. E. Barrett, who will speak to you.

Mr. Barrett then spoke briefly in regard to the duties of his position.

The first paper of the afternoon was by Frederick N. Connett, mechanical engineer, Providence, R. I., on "Some Recent Applications of the Venturi Meter." The paper was illustrated by stereopticon views. The discussion of the paper was opened by Mr. Allen W. Cuddeback, who read a letter from Mr. John H. Cook, hydraulic engineer of the East Jersey Water Company. Mr. Richard A. Hale spoke of the successful work of the Venturi meter at Lawrence, and Mr. Connett replied to questions asked by Prof. Dwight Porter and Mr. Frank L. Fuller.

MR. RICHARD K. HALE. Mr. President, it has come to my attention that several people have commented upon certain features of our Standard Specifications for Cast-Iron Pipe, and suggested revision. It has been suggested, therefore, that the matter be referred to the Committee on Cast-Iron Pipe, to determine whether these specifications should be revised or not. I therefore make the following motion: That the question of the desirability of revising the Standard Specifications for Cast-Iron Pipe be referred to the Committee on Pipe Specifications, with the request that they report on this matter at the next meeting of the Association.

THE PRESIDENT. You have heard Mr. Hale's motion; is there anything to be said?

MR. DEXTER BRACKETT. As a member of that committee, I would like to ask if it is contemplated to refer the matter back to the original committee. I supposed that that committee had long ago gone out of existence.

MR. HALE. I am informed that this committee is still in existence and that you are the chairman, and that Mr. McInnes and Mr. Forbes are the other two members.

MR. BRACKETT. I wish to state that while I think it is desirable that the question of the Standard Specifications be considered, with a view of possibly adopting some changes which the experi-

ence of the last ten years has shown advisable, I should not be willing to retain the chairmanship of that committee, and really I should prefer not to be a member of it. I am, however, willing to give the benefit of any experience I may have had in the previous study of the question. I should think it would be well to have a committee of five, as I know there is much work to be done, and that the committee be appointed by the President. As to that committee making any report at the next meeting if that would mean anything in the shape of suggesting changes, I think there would be hardly time for that. I only offer this as a suggestion.

THE PRESIDENT. Mr. Brackett, the idea is simply that the committee will report on the advisability of making changes, — not to suggest the changes, but, if they deem it advisable and proper to have changes made, to report back to the Association at the next meeting so that we may act upon the matter then, and decide whether to appoint a new committee or to continue the old committee.

MR. BRACKETT. If that is the idea, I am satisfied.

(Mr. Hale's motion was adopted.)

THE PRESIDENT. The Executive Committee have been looking about for a place to hold the next annual convention. We sent out notices to the members, as you know, asking them to express their preferences. We have had 171 replies, and a summary of those replies is as follows:

First choice: Washington, 72; New York, 62; Philadelphia, 36. Scattering, 1.

Second choice: Washington, 26; Philadelphia, 71; New York, 37. Scattering, 2.

The committee have not yet decided upon the place, but they will probably be somewhat guided by the replies received from the members.

Mr. William S. Johnson, sanitary and hydraulic engineer, Boston, Mass., read a paper entitled "Some Things Domestic Meters do Not Accomplish." This paper was also illustrated by the stereopticon. It was discussed by Mr. Dexter Brackett, Mr. Allen W. Cuddeback, Mr. Frank L. Fuller, and Mr. George A. Carpenter.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Wednesday, December 13, 1911.

Present: President Allen Hazen, and members Morris Knowles, Lewis M. Bancroft, Richard K. Hale, Robert J. Thomas, and Willard Kent.

Five applications for membership were received and recommended for admission, namely:

For membership: John L. Hyde, city engineer, Westfield, Mass.; Walter E. Miller, C. E., Railroad Commission of Wisconsin, Madison, Wis.; Charles H. Ross, superintendent Waterloo Water Company, Waterloo, N. Y.; Alfred A. Young, superintendent Jewett City Water Company, Jewett City, Conn.

For associate: Eddy Valve Company, manufacturers of valves and hydrants, Waterford, N. Y.

Adjourned.

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, January 10, 1912, at 11.30 A.M.

Present: President Allen Hazen, and members J. Waldo Smith, Michael F. Collins, Leonard Metcalf, Irving S. Wood, Frank A. McInnes, Morris Knowles, Lewis M. Bancroft, Richard K. Hale, and Willard Kent.

Six applications for membership were received and recommended for admission, namely:

Sam H. Pitcher, assistant engineer, Worcester, Mass.; Hervey A. Hanscom, contracting engineer, Boston, Mass.; Lewis L. Wadsworth, president Hanscom Construction Company, Boston, Mass.; Herbert F. Salmonde, chemist West Parish Filters, Springfield Water Works, Westfield, Mass.; Paul Hansen,

engineer Illinois State Water Survey, University of Illinois, Urbana, Ill.; Harrington P. Stearns, assistant engineer Queens County Water Company, Far Rockaway, N. Y.

Adjourned.

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, at 2.30 P.M., Friday, January 26, 1912, pursuant to call of President.

Present: President George W. Batchelder, and members Frank A. McInnes, Randolph Bainbridge, Lewis M. Bancroft, Richard K. Hale, George A. King, and Willard Kent.

Voted: On motion of Mr. King, seconded by Mr. Bancroft, that the Secretary be instructed to send with the notices of the February meeting a request for the members to express their preference of a place for holding the next annual convention.

Adjourned.

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at the rooms of the Association, Tremont Temple, Boston, Mass., February 14, 1912, at 11.30 A.M.

Present: President George W. Batchelder, and members Frank A. McInnes, George A. Stacy, Richard K. Hale, George A. King, and Willard Kent.

The Treasurer's bond for $5 000, by the Massachusetts Bonding and Insurance Company, was presented and by unanimous vote approved.

Ten applications for membership were received and recommended for admission, namely:

For members: Henry Newhall, superintendent water works, Danvers, Mass.; J. J. Prindiville, water commissioner, Framingham Mass.; Charles A. Leary, engineer, Commission of Public Works, Peabody, Mass.; Charles W. Saxe, chemist in charge Filtration Plant, Newport, R. I.; Earl W. Kelly, engineer Water

and Light Department, Duluth, Minn.; Myron L. Fuller, consulting engineer, Boston, Mass.; L. E. Thayer, trustee Kennebec Water District, Waterville, Me.; Samuel R. Hatch, assistant to manager, Water and Light Department, Duluth, Minn.; Marvin C. Birnie, civil engineer, Springfield, Mass.; Howard C. Ives, professor water supply and railroad engineering, Worcester Polytechnic Institute, Worcester, Mass.

The result of ballot by members on place of holding next annual convention was presented as follows:

Replies were received from 171 members.

	First Choice.	Second Choice.
Washington	72	26
Philadelphia	36	71
New York	62	37
Boston	1	1
Providence	..	1

After a discussion, the matter was referred to a later meeting of the Executive Committee.

Adjourned.

WILLARD KENT, *Secretary.*

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Water Meters

FOR ALL WATER WORKS SERVICE

All Sizes, 5-8 to 60 inches

CROWN

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NASH

GEM

PREMIER

With the only reliable straight-reading register in the market

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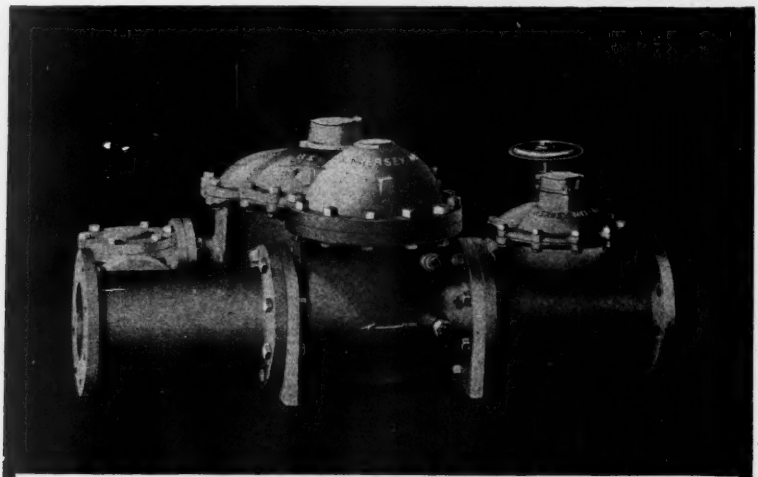

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THIS IS THE ONLY METER

WHICH REGISTERS ALL LARGE FLOWS
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"ALL KINDS OF METERS FOR ALL KINDS OF SERVICES"

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ACCURACY, LONG LIFE,

Avoidance of Repairs

Are the Requisites of the Perfect Water Meter and are the Principal Features of the

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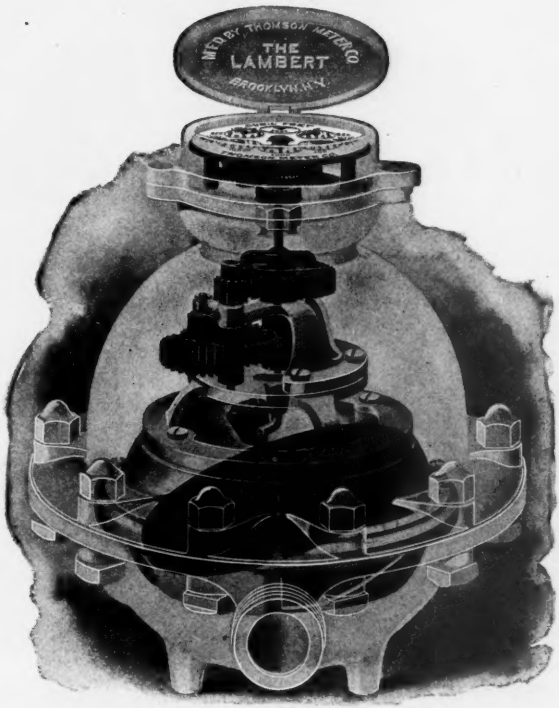

Our unbreakable disk-piston, reinforced with an internal steel plate, can be found only in the **LAMBERT METER.**

The growing popularity of the water-meter system is attributed by many to the inherent excellence of the **"LAMBERT"** meter. Where **"LAMBERT"** meters are selected, success is assured.

THOMSON METER CO.

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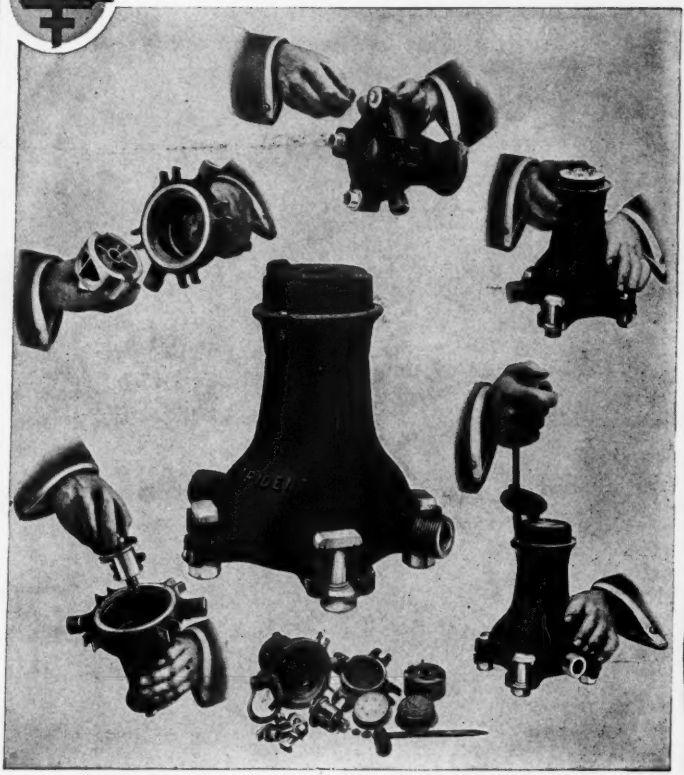
TRIDENT WATER METERS



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The above cut shows a Trident-Disk Meter dismantled and the extreme ease with which it can be assembled, by first putting in the gear train, then the disk-chamber, the frost bottom next, then the register and register box and the meter is complete. The Trident combination wrench is the only tool necessary to use.

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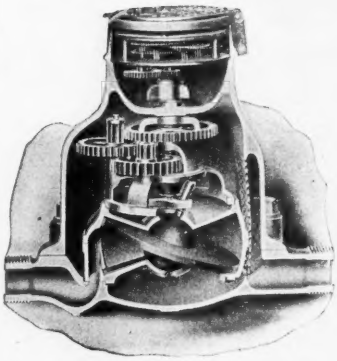
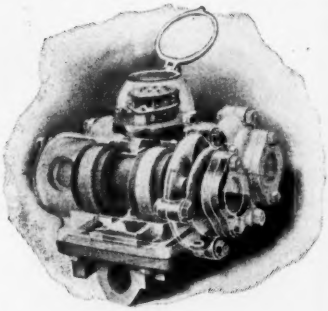
SEATTLE, 115 Prefontaine Place — SAN FRANCISCO, 149 New Montgomery St.

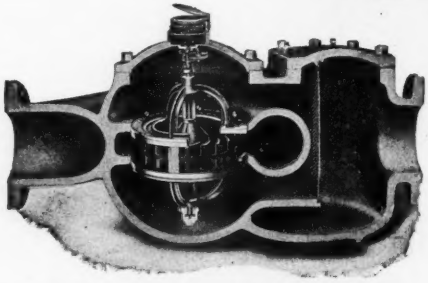
WORTHINGTON METERS



The Worthington Disc Meter combines minimum weight with reliability on constant service and accuracy of registration.



The Worthington Duplex Piston Meter is particularly adapted to large and heavy water works services.



The Worthington Turbine Meter
is designed primarily to handle large volumes of water with minimum loss of pressure.

Full descriptions of the different types of Worthington Meters, with tables of sizes and capacities, are given in Bulletin W184–54.

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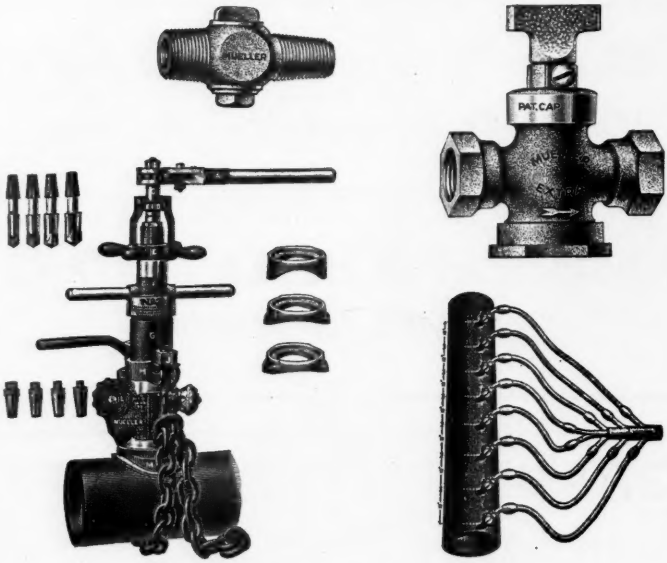

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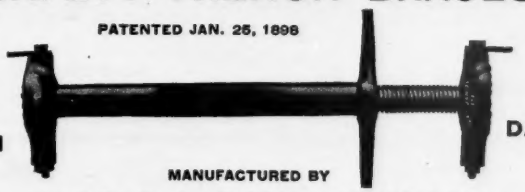

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PIPE JOINTERS LEAD FURNACES

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Over 100 Water Departments

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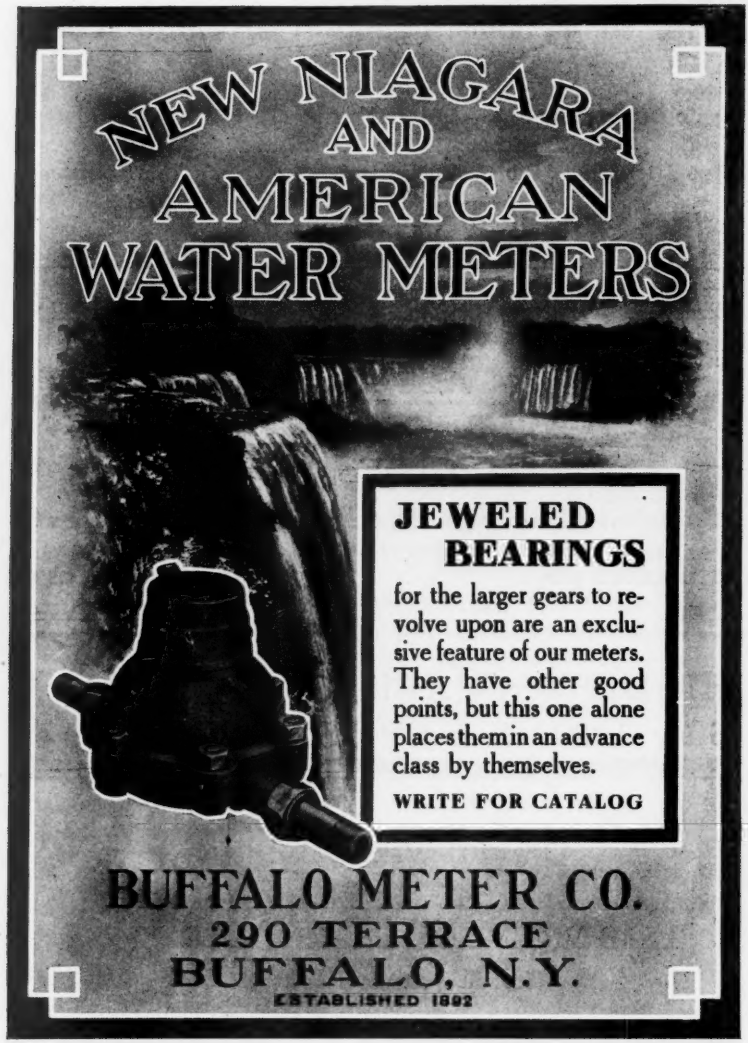
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for the larger gears to revolve upon are an exclusive feature of our meters. They have other good points, but this one alone places them in an advance class by themselves.
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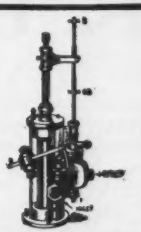

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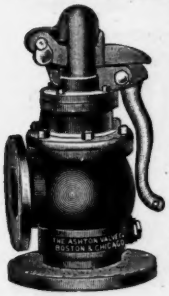

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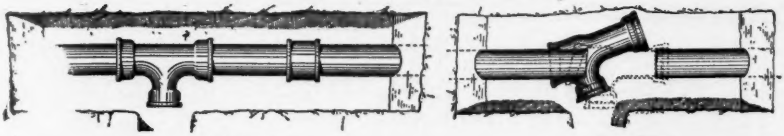

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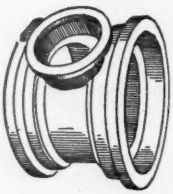

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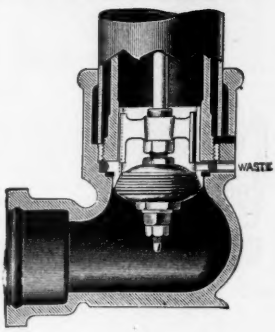

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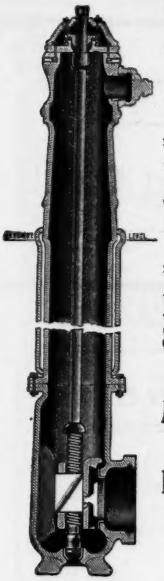

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The drip is directly in the bottom of the hydrant and drains perfectly. It is protected by its valve, which never leaves its socket and cannot be clogged.

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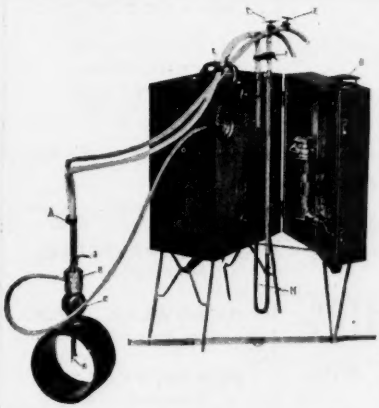

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SUCCESSFUL
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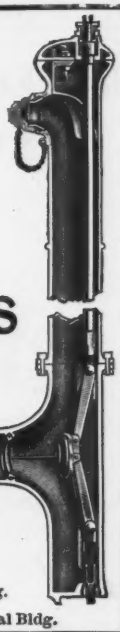

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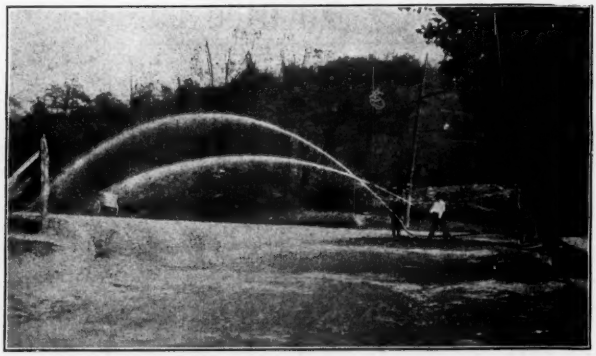

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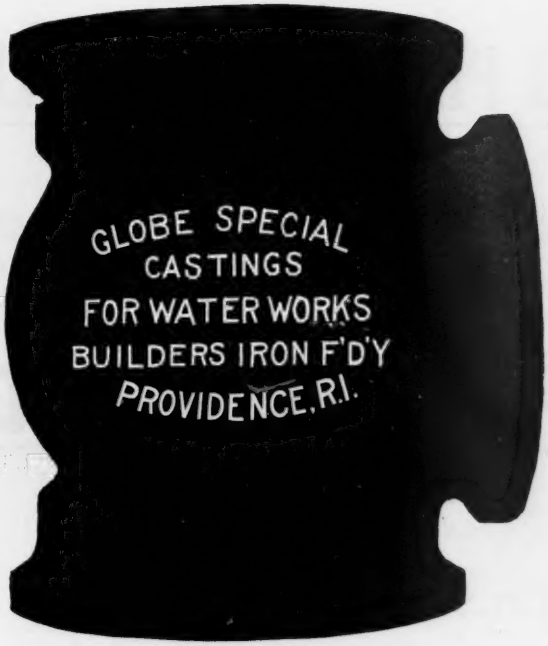
AND



Builders Iron Foundry

PROVIDENCE, R. I.

Established 1820 *Incorporated 1853*

Chadwick-Boston Lead Co.

Corner Congress and Franklin Streets

162 Congress St. **BOSTON** **180 & 182 Franklin St.**

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Patent Tin-lined Pipe

Pure Block Tin Pipe

PIG LEAD

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Perolin

from Germany

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But it had a big duty to perform, so, to avoid the Import Tax, it came in the form of a formula — *D. R. Dampf-Kessel-Mischung* is what the Germans call it. Translated into boiler talk this means

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And that it does "'Raus Mit 'Em" is proved by the fact that in Germany and Europe eleven large factories are taxed to their full capacity in supplying the enormous demand.

Perolin German Boiler Compound

was first introduced in this country two years ago. During this short period it certainly has lived up to its home reputation, for the names of over 4,000 customers are on our books today, and they use *Perolin* exclusively.

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EAGLE OIL & SUPPLY CO.
I will cheerfully show any skeptic, as I was at first, that Perolin does the work—I shall continue to use it and find it cheaper than sal soda.
Chief Engineer
Jordan Bldg., Boston

McLane Mfg. Co.
Milford, N. H.
EAGLE OIL & SUPPLY CO.
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We have been using your boiler compound for three months and find it will remove scale, and we do not observe any injury to boiler.
McLane Mfg. Co.

And in each instance *Perolin* went in "on trial," without requesting a "Jug of Feed Water" or a "Sample of Scale for Chemical Analysis," for the source of your water supply and the character of scale it deposits are merely incidental.

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EAGLE OIL & SUPPLY CO. BOSTON, MASS.

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Registered U. S. Patent Office

FOR

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2. **NO CAULKING.** Leadite joints require no caulking, because the Leadite adheres to the pipe, making a water-tight bond.
3. **COMPARATIVE QUANTITIES.** One ton of Leadite is equivalent to four tons of lead.
4. **LABOR SAVING.** Saves caulking charges and digging of large bell-holes, and reduces the cost of trench pumping to the minimum.
5. **COST.** Its use saves 50 to 65 per cent. over lead, owing to the saving effected in material and labor.
6. **TOOLS.** As no caulking is required, fewer tools are needed.
7. **TRANSPORTATION.** Considerable freight charges are saved because Leadite is lighter than lead.
8. **HAULING.** Saves hauling expense on the work because you move only one fourth the weight of jointing material.
9. **FUEL.** Saves fuel because you melt only one ton of material instead of four, and not as much heat is required either.
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11. **DAMAGE SUITS.** Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.
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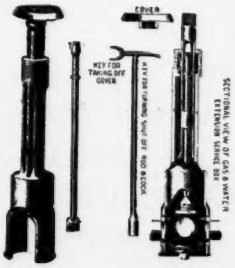

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